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W. C. ROENTGEN AND THE DISCOVERY OF THE ROENTGEN RAYS*

By OTTO GLASSER, PH.D.
Cleveland Clinic
CLEVELAND, OHIO

THIRTY-FIVE years ago, on November 8, 1895, Wilhelm Conrad Roentgen made the revolutionary discovery of a mysterious new kind of ray which he called the "x-ray." Thirty-five years is too short a period of time in which to obtain the proper perspective by which to judge the significance of this revelation or to appreciate fully the genius of the man who made this remarkable discovery and beneficently gave it to the world. On the other hand, thirty-five years is so long ago that it is difficult to obtain authentic facts from original sources bearing directly upon the manner in which the existence of the roentgen rays was first revealed to their discoverer. Fortunately, however, there are some persons still living who had personal and intimate contact with Roentgen and can relate their experiences with authority, and who can also vouch for the veracity of the early reports of the discovery.

According to the statements made by these persons, this peculiar and inexplainable phenomenon was first manifested by the fluorescence of a small barium platinum cyanide screen under the influence of the penetrating rays emitted from an excited Crookes tube. A detailed description of Roentgen's discovery was given by Sylvanus P. Thompson, a well-known English physicist, himself an enthusiastic x-ray research worker and president of the newly founded British Roentgen Society, at a meeting held on Friday, November 5, 1897, at St. Martin's Town Hall in London. Roentgen had modestly declined an invitation to address this historic meeting. Thompson's report of the discovery agrees with many others, and according to our studies, must have related the events as they actually occurred. Sylvanus P. Thompson said in this address:

> November the eighth, 1895, will ever be memorable in the history of Science. On that day a light which, so far as human observation goes, never was on land or sea, was first observed. The observer, Prof. Wilhelm Conrad Roentgen. The place, the Institute of Physics in the University of Würzburg in Bavaria. What he saw with his own eyes, a faint flickering greenish illumination upon a bit of cardboard, painted over with a fluorescent chemical preparation. Upon the faintly luminous surface a line of dark shadow. All this in a carefully darkened room, from which every known kind of ray had been scrupulously excluded. In that room a Crookes's tube, stimulated internally by sparks from an induction coil, but carefully covered by a shield of black cardboard, impervious to every known kind of light, even the most intense. Yet in the darkness, expressly arranged so as to allow the eye to watch for luminous phenomena, nothing visible until the

* Read at the Thirty-First Annual Meeting, American Roentgen Ray Society, West Baden, Ind., Sept. 23–26, 1930. Seventy illustrative slides were shown at this meeting but on account of lack of space only seven are presented with this paper.

hitherto unrecognized rays, emanating from the Crookes's tube and penetrating the cardboard shield, fell upon the luminescent screen, thus revealing their existence and making darkness visible.

From seeing the illumination by the invisible rays of a fluorescent screen, and the line of shadow across it, the work of tracing back that shadow to the object which caused it, and of verifying the source of the rays to be the Crookes's tube, was to the practised investigator but the work of a few minutes. The invisible rays—for they were invisible save when they fell upon the chemically painted screen—were found to have a penetrative power hitherto unimagined. They penetrated cardboard, wood, and cloth with ease. They would even go through a thick plank, or a book of 2000 pages, lighting up the screen placed on the other side. But metals such as copper, iron, lead, silver and gold were less penetrable, the densest of them being practically opaque. Strangest of all, while flesh was very transparent, bones were fairly opaque. And so the discoverer, interposing his hand between the source of the rays and his bit of luminescent cardboard, *saw* the bones of his living hand projected in silhouette upon the screen. The great discovery was made.

This report, given here in the exact words of the great English scientist, was published in November, 1897, in the second volume of the world's first journal of roentgenology the English *Archives of Skiagraphy*, or as it was afterwards called, the *Archives of the Roentgen Ray*.

Inevitably many stories and fables are spun about discoveries and inventions of great significance and the birth of the x-ray did not escape this fate. The most popular story, perhaps, is the myth of the book and the key. It is repeated from time to time and recently again made the rounds through the newspapers in the following form:

Prof. Roentgen once placed an experimental electric tube upon a book beneath which was a photographic plate holder, loaded. Some time later he used the plate in his camera and was puzzled, upon developing it, to find the outline of a key on the plate. He investigated and discovered a key between the pages of the book on which the experimental lamp had rested. The strange "light" from the electrical discharge in the glass tube had penetrated the covers and pages of the book and the shield of the plate holder. Thus the x-ray was discovered.

I have found this story to be unknown outside of the United States, and it certainly did not originate in Germany, but it is one which appeals to the imagination of the general public. It seems to be traceable to an account of a Chicago scientist by the name of T. S. Middleton who in 1895 was a student at the Würzburg University and who incorrectly placed the date of the discovery in the Spring of the year 1895.

This story contains some inaccuracies even in its original form. The incident might have taken place after the discovery of the rays and if it did occur it might have directed Roentgen to the study of the photographic effect of the rays, but there are many reasons for questioning the veracity of this tale. Roentgen never spoke of any observations which might have had anything whatever to do with such an experiment. If this observation had been made in April, 1895, Roentgen would certainly have been the first to refer to it because he was always most conscientious and accurate in recording his data. Even Roentgen's two assistants, one of whom helped him to operate the vacuum pump with which the Hittorf and Crookes tubes were evacuated, did not know about the discovery of the x-ray until it was publicly announced late in December. If these coworkers who were in rather intimate touch with Roentgen's work did not know about the discovery until it was announced publicly, how much less insight must the students at the University have had into the work of their Professor! One of the few persons who knew about the discovery before the announcement was made was Roentgen's wife, Bertha. One evening in November, 1895, she became very angry with her absent-minded husband because he did not comment upon the excellent dinner she had prepared for him, and he did not even notice that she was angry until she asked him what was the matter. He finally took her down-

stairs to his laboratory, which was in the same building, and for the first time presented to her astonished eyes the wonders of the x-ray. We have in our museum a letter which Mrs. Roentgen wrote in March, 1896, to Prof. Roentgen's cousin, Mrs. L. R. Grauel of Indianapolis, in which she relates how her husband told her of the discovery for the first time in November, 1895. This statement is, therefore, of great significance as it fixes the date of the discovery.

Another fable connected with the discovery, which occasionally emerges from oblivion and which was even recently broadcast by radio from Hamburg, is the story that the first observation of the fluorescent light was made by Roentgen's lab-

Fig. 1. Photograph of Wilhelm Conrad Roentgen taken at the time of his discovery of the x-rays. (From "Les Prix Nobel en 1901," Norstedt, Stockholm, 1904.)

oratory servant. It is perhaps of psychological interest that envious or ignorant individuals often repeat such stories in spite of well-founded historical facts to the contrary.

Roentgen's adopted daughter, who now lives in Hanover, Germany, but who at the time of the discovery was living with her foster parents in the Würzburg Institute, states in a letter of April 2, 1930, that she remembers very distinctly that on the evening in which her father discovered the rays he was alone in his laboratory. Roentgen himself wrote a letter to Mrs. Boveri on April 28, 1921, in which he says in his characteristic manner: "Do you know that now Zehnder also heard the story that I did not make the first observation of the effects of the x-rays but that an assistant or servant discovered them. What miserable envious man has invented this story?"

Was Roentgen's discovery of the roentgen rays accidental? Popular opinion would have us believe that it was! However, a careful study of the personality and the scientific background of Roentgen himself, as well as the events which led up to the actual discovery, and of the published comments of contemporary scientists, should emphatically disprove this theory. Roentgen was undoubtedly one of the outstanding physicists of the nineteenth century, even without taking into consideration his discovery of the roentgen rays. He began to experiment with cathode rays in October, 1896, because he was interested in many riddles which still existed in spite of valuable contributions to the subject which had been made by other investigators. Like all research scientists he was on the lookout for new phenomena, and was following in the path of all of his illustrious predecessors from von Guericke to Lenard when he discovered "a new kind of ray." Roentgen's discovery was the final step in a brilliant and logical correlation of a multitude of facts which had been disclosed by many scientists. His glance at the fluorescent screen may be said to be the only accidental incident connected with the discovery. But how well Roentgen knew the explanation of this almost insignificant phenomenon! Many scientists before him—Crookes, Goodspeed, Goldstein, Lenard, and others—had made similar observations but had entirely forgotten about them until Roentgen's announcement was made. It was his keen observation and the accuracy of his critical judgment, together with his great experimental skill which made his discovery of such tremendous significance.

It is interesting to note that one year before Roentgen made his discovery he gave an address as the President of the Würzburg University and in this speech quoted some of the thoughts of one of his predecessors in the chair of Physics and Philosophy, Prof. P. A. Kircher, who as early as 1602 made the following statement: "Nature often reveals the most astonishing phenomena by the simplest means, but these phenomena can only be recognized by persons who have sharp judgment and the investigative spirit, and who have learned to obtain information from experience, the teacher of all things." How applicable this centuries-old assertion was destined to become in the case of Roentgen's own discovery and how strange that he should have quoted it a year before the great event! Very similar in spirit was that short comment which was made by the philosopher, Münsterberg, of Harvard University, shortly after the announcement of the discovery when he refused to subscribe to the idea that it was entirely accidental by saying, "Suppose chance helped, there were many galvanic effects in the world before Galvani saw by chance the contraction of a frog's leg on an iron gate. The world is always full of such chances, and only the Galvanis and Roentgens are few."

After the first observation of the fluorescent effects of the unknown rays, Roentgen feverishly followed the clue and in the next few weeks performed an astonishing number of carefully planned experiments. We know from his wife's story that Roentgen seldom emerged from his laboratory during these weeks, that he had his meals there, and that

he even slept there part of the time in order to be undisturbed and to be ready day or night to try out any new ideas that might come to him in the course of his work. Such new ideas certainly must have been numerous. Today it is difficult to imagine the multitude of unknown and complicated phenomena with which the scientist had to wrestle during those first days. The replacing of the fluorescent screen by the recording photographic plate was one of his first important successful steps. Many of his first pictures which show the varying absorbability of many materials were produced in this way. His first roentgenograms of the hand of his wife (Fig. 2), a compass, metal weights in a wooden box, and so forth, have come to have historic significance. At first the photographic plate became more popular as a method of demonstrating the effects of the new rays, and for a time this method overshadowed the use of the fluorescent screen to such a degree that the latter almost faded into oblivion, reappearing, however, many months later under the name of the Edison fluoroscope, Salvioni cryptoscope, and so forth, when it was hailed enthusiastically as another new discovery which made the rays visible to the eye. It seems that the significance of this supposed improvement almost eclipsed that of the discovery of the rays. Essentially, however, these improvements were only slight modifications of Roentgen's original experiment.

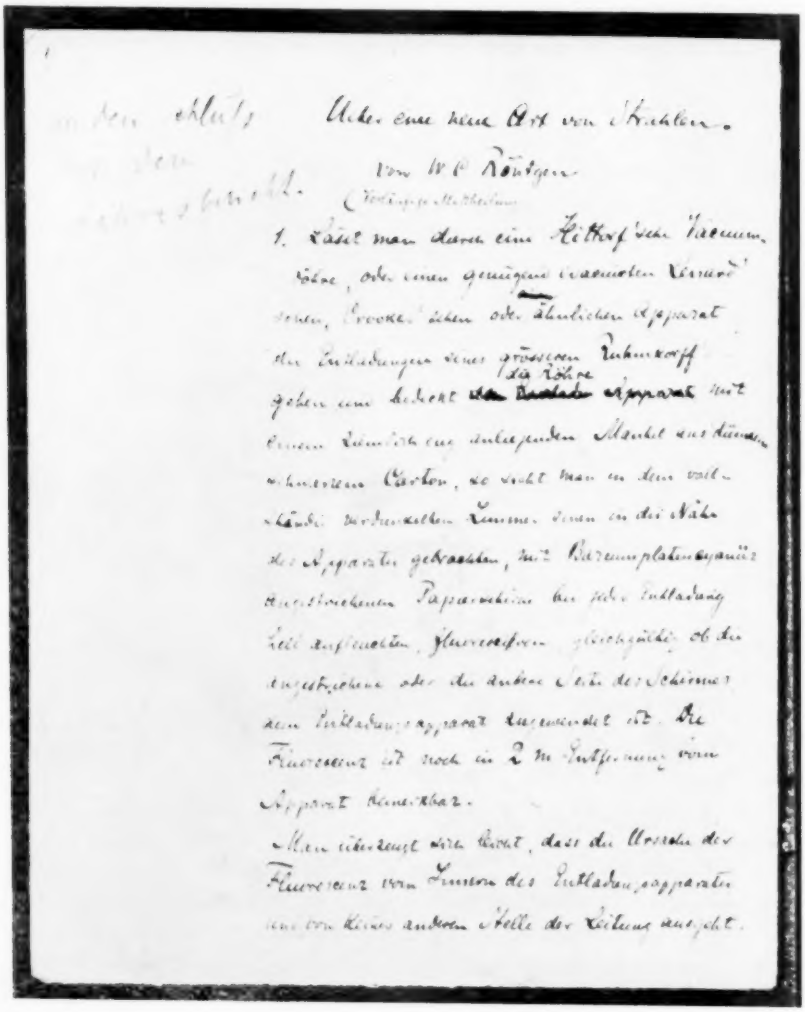
By means of his screen and plates Roentgen made all of the fundamental observations which he reported in his first two classical communications with such accuracy and thoroughness that other physicists and investigators could add nothing new to the master's original work until many years later. Roentgen showed the propagation of the rays in straight lines. He observed that they were not reflected or refracted or deviated by the influence of magnetic fields. He investigated the penetration of the rays through different materials which are entirely opaque to ordinary light. He made observations on the hardening of the rays by absorption, the creation of secondary radiation and the conductivity of air when traversed by the rays, and recorded many other properties.

Fig. 2. First x-ray picture of a hand taken by Roentgen in November, 1895. (Courtesy of the Physical-Chemical Institute of the University of Vienna, Prof. Dr. E. Haschek.)

On December 28, 1895, Roentgen handed his "preliminary" communication, "On a New Kind of Ray," to the President of the Würzburg Physical Medical Society (Fig. 3). It was accepted for publication in the Annals of the Society for the year 1895, although he had not yet lectured on the subject. No meetings or lectures are given in German universities during the Christmas vacation, therefore Roentgen waited until the 23rd of January, 1896, before he spoke publicly on the subject of his discovery for the first and apparently the only time.

During this month the news of the discovery travelled with almost unbelievable rapidity from the quiet laboratory of the

sleepy little town on the river Main to the four corners of the world. The public press in the capitals of Europe and America printed the news even before the Würzburg newspaper, the *General Anzeiger*, printed its first report. This sudden world-wide publicity was not entirely to the liking of the modest discoverer, and the earliest reports went to press without his consent. He had sent some of his first x-ray pictures to a few friends, before the news of the discovery was published. One of these was Prof. F. Exner in Vienna, who had been a friend of Roentgen since their college days in Zurich. One evening Exner showed the pictures to a little gathering of fellow scientists. They naturally created quite a sensation and some heated comments were made. Prof. Ernst Lecher of Prague asked Exner to let him have the prints until the next morning. Late at night Lecher hastened to bring the good news to his father, Z. K. Lecher, who was then the publisher of the *Wiener Presse*. Even in those days newspaper men had their uncanny sense for news, and the next morning edition of the



Über eine neue Art von Strahlen.

Von W. C. Röntgen

Fig. 3. Original manuscript of Roentgen's first paper "On a New Kind of Ray." (Courtesy of the Physical Institute of the University of Würzburg, Director, Prof. Dr. Harms.)

Presse contained an elaborate article on the revolutionary discovery by the "Würzburg Professor." The news was quickly copied by other continental papers and on the evening of January 6, 1896, it was cabled from London to all of the civilized countries of the world in the following words: "The noise of war's alarm should not distract attention from the marvellous triumph of science which is reported from Vienna. It is announced that Prof. Routgen of the Würzburg University has discovered a light which for the purposes of photography will penetrate wood, cloth and most other organic substances." A more detailed report of the discovery followed the next morning, and in a few days the almost unbelievable story of the "all-penetrating rays" had found its way not only into the newspapers but also into the scientific journals.

The *Electrical Engineer, New York*, reported the discovery on January 8, 1896 (Vol. 21, p. 51), under the title, "Electrical Photography through Solid Matter"; the *Electrician, London*, followed with an article on January 10, 1896, (Vol. 36, p. 334), under the headline "Sensational Worded Story." A detailed article also appeared in the January number of the Italian *Il nuovo cimento*, while the French *L'eclairage electrique* published its first comments on the discovery on February 6, 1896. The London *Nature*, and the New York *Science* had somewhat more elaborate articles in their issues of the 16th and 25th of January.

Although at first it appeared as if the technical journals would claim the discovery, the valuable medical possibilities of the use of the x-ray for diagnostic purposes immediately became apparent and the *Münchener medizinische Wochenschrift* of January 14, 1896, reported a meeting of the Berlin Society of Internal Medicine, which took place on January 6, 1896, at which the neurologist, Dr. Jastrowitz, spoke on Roentgen's discovery. Further comments appeared in the same journal the following week. On January 16 the *Wiener klinische Wochenschrift* (Vol. 96, p. 48), reported Prof. S. Exner's talk on the x-ray. The English *Lancet* and also the *British Medical Journal* contained the first news in their issue of January 11 under the title, "The Searchlight of Photography"; the French *Comptes rendus* of January 20, and the Italian *La settimana medica* of January 25, under the title "Experiences with the Roentgen Light," *Medical Record*, New York, January 11, 1896, under the title "Illuminated Tissues," and the *Journal of the American Medical Association* on February, 15, 1896. These early communications show the alacrity with which the medical profession accepted the new weapon and promptly used it to good advantage, at the same time anticipating the vast possibilities of improving diagnosis by improving the new tool. Even the fondest hopes of those first days following the discovery were soon surpassed in the romantic development of roentgenology.

Roentgen's name and the news of his discovery thus became known throughout the whole world, and much progress had already been made even before the modest discoverer spoke for the first and only time on his "New Kind of Ray." The lecture was given before the Physical Medical Society of the University of Würzburg on January 23, 1896, in the auditorium of Roentgen's Physical Institute. Long before the meeting began every seat of the large room was occupied. Professors of the University, high officials of the city, representatives of the Army, and many students, filled the room. With great excitement and enthusiasm the crowd was waiting for the discoverer, and when he entered a veritable storm of applause arose which was repeated many times during the evening. Roentgen modestly expressed his thanks and just as modestly began to talk about his work. He emphasized first that on account of the general interest he thought it his duty to speak publicly about his "Arbeit," although the experiments were still in the course of development. He then mentioned the investigations with cathode rays made by Hertz, Lenard, and others, and said that

his own observations had led him to make experiments along the same lines which resulted in his discovery. He related how he first observed the fluorescence of a small

Fig. 4. Roentgenogram of von Kölliker's hand, taken by Roentgen after his first lecture on the x-ray on January 23, 1896.

piece of paper painted with barium platinum cyanide and how he quickly found out that the cause for this fluorescence came from the carefully covered Hittorf tube itself, and not from any other part of the high tension circuit. "I found by accident," the discoverer said, "that the rays penetrated black paper. I then used wood, paper, books, but I still believed I was the victim of deception. Then I used photography and the experiment was successful."

Roentgen demonstrated numerous successful experiments with the x-rays and also mentioned his well-known earlier attempts to make photographs through a door in his laboratory with the result that he found light strips on the exposed plate which were unexplainable. Upon dismantling the door he found that the strips of white lead which held the panels of the door together, were responsible for the increased absorption of the rays and caused the light strips on the plate. He then exhibited various x-ray pictures and they, of course, excited the greatest interest. After the demonstration Roentgen asked the famous anatomist of the University, His Excellency von Kölliker, to permit him to photograph his hand (Fig. 4). Von Kölliker eagerly complied with this request and when the excellent picture was shown a little later there was tremendous applause and all present felt that this was a moment of real historical significance. Von Kölliker said feelingly that in his forty-eight years of membership in the Physical Medical Society he had never attended a meeting at which a subject of such great significance had been presented. He finished with three cheers for the discoverer and proposed that henceforth the x-rays be called roentgen rays. This suggestion was adopted amid renewed applause for Roentgen. The general optimism was again expressed in a short discussion and only one of those present, the surgeon, Prof. Schoenborn, warned against too much optimism since the method hardly promised to be of much if any value in diagnosing internal disturbances.

Prof. Lehman, who was then President of the Physical Medical Society and now is Professor of Hygiene at the Würzburg University, has related part of the story given above and substantiated some of the early reports of this meeting which appeared in various journals. He stated recently that many of those present at the meeting met afterwards and had a glass of beer, and that they looked with keen optimism into the future, but "whatever our dreams then expected, they have been far surpassed by the actual facts."

From then on a veritable flood of articles on the new "wonder rays" appeared in rapid succession in the press of the whole world. I have been able to collect over a

FIG. 5. Two early cartoons of Roentgen's discovery of a "New Photography." (From "*Punch*" and "*Life*.")

thousand articles on x-rays which appeared in scientific journals during the year 1896. Over fifty books on the same subject were published in the same year, not to mention the innumerable comments which appeared in some of the popular and semi-scientific journals.

The cartoons and poems appearing in many popular magazines and newspapers form a most interesting part of the early printed records of the discovery and give us a good idea of its reception by the general public (Fig. 5). Not infrequently they express a certain fear of the ghastly skeletal pictures which was voiced also in many publications. As an example we may quote from the London *Pall Mall Gazette*:

> We are sick of the roentgen rays. It is now said, we hope untruly, that Mr. Edison has discovered a substance—tungstate of calcium is its repulsive name—which is potential, whatever that means, to the said rays. The consequence of which appears to be that you can see other peoples bones with the naked eye, and also see through eight inches of solid wood. On the revolting indecency of this there is no need to dwell. But what we seriously put before the attention of the Government is that the moment tungstate of calcium comes into anything like general use, it will call for legislative restriction of the severest kind. Perhaps the best thing would be for all civilized nations to combine to burn all works on the roentgen rays, to execute all the discoverers, and to corner all the tungstate in the world and whelm it in the middle of the ocean. Let the fish contemplate each other's bones if they like, but not us.[1]

This same ignorance and pessimism found expression in jokes and poems as well as in everyday life. On February 19, Assemblyman Reed, of Somerset County, New Jersey, introduced a bill into the House at Trenton, New Jersey, prohibiting the use of x-rays in opera glasses at theaters,[2] and in London, England, a firm "made prey of the ignorant women by advertising the sale of x-ray proof underclothing."[3] Numerous poems were published, one of which reads:

> O Roentgen, then the news is true
> And not a trick of idle rumor,
> That bids us each beware of you
> And of your grim and graveyard humor.

[1] *Brit. J. Photography*, March 27, 1896, *43*, 197.
[2] *Elect. Eng.*, Feb. 26, 1896, *21*, 216.
[3] *Elect. World*, 1896, p. 39.

We do not want, like Dr. Swift
To take our flesh off and to pose in
Our bones, or show each little rift
And joint for you to poke your nose in.

We only crave to contemplate
Each other's usual full dress photo
Your worse than "alltogether" state
Of portraiture we bar in toto!

The fondest swain would scarcely prize
A picture of his lady's framework;
To gaze on this with yearning eyes
Would probably be voted tame work.

No, keep them for your epitaph,
These tombstone souvenirs unpleasant;
Or go away and photograph
Mahatmas, spooks and Mrs. Besant.*

—From London "*Punch*," January 25, 1896.

However, this scattered opposition could by no means stop the triumphal course of events. The hopeful individuals by far outnumbered the fearful ones, some of them even believing that with the new knowledge all the age-old problems of spiritualism, soul photography, vivisection, temperance movements, Philosopher's stone would be solved. The New York newspapers actually reported that at the College of Physicians and Surgeons the roentgen rays were used to reflect anatomical diagrams directly into the brains of the students, making a much more enduring impression than the ordinary methods of learning anatomical details.[4]

A romantic chapter in the history of science is the story of the feverish activities which were in progress in laboratories all over the world during the first weeks following Roentgen's great discovery. Many prior claims were made and many attempts were made to find a better name for the new phenomenon. In rapid succession came suggestions for technique and for practical uses for the rays in medicine, and efforts were made to solve the secret of the essential character of these rays. First observations of the physiological effects of the rays, especially on the human skin, were soon reported. It would lead much too far, however, to discuss at this time all the fascinating phases of Roentgen's discovery. They have been dealt with in detail in my book.[5]

Very quickly Roentgen's work received proper recognition. Emperor Wilhelm invited him to Potsdam to give a demonstration of his discovery and conferred a decoration upon him. The Prince Regent of Bavaria, Luitpold, bestowed upon him the "Verdienst Orden" of the Bavarian crown with which the coveted "von," the sign of nobility was connected. Roentgen declined to accept this latter honor. His University gave him an honorary degree of M.D., and his birthplace, Lennep, made him an honorary citizen. Italy decorated him with the Order of the Italian Crown and England gave him the Rumford Medal. He was honored by the whole world as hardly any scientist had been before, but still he remained a modest, industrious man. In spite of all the excitement about him he continued his work after his first publication was printed, and as early as March, 1896, he was ready to give his second communication to the press, this being an important addition to his first paper.

Mrs. Roentgen gives us a good insight into the strenuous life which Roentgen led during this time in the letter to her cousin which we mentioned earlier in this paper. She wrote on March 6, 1896:

It is not easy to be a famous man, and very few people have any conception of how much work and how much excitement it carries with it. Our quiet home life was gone as soon as my

* In this connection, it is interesting that a recent number of Time (Feb. 9, 1931) contained a review of a biography just published of Mrs. Besant—"The Passionate Pilgrim" by Gertrude Marvin Williams. The first paragraph of this review is as follows: "Annie Wood Besant (rhymes with either incessant or pleasant) is an old woman (83) popularly associated with occult ritual and mystic robes. She is still president of the Theosophical Society, but perhaps you didn't realize she was once a parson's wife, an atheist, a Socialist, a beautiful spellbinder." And the review concludes: "At present she is a still energetic old woman who stands as temporal Head to some 43,000 scattered Theosophists."—Ed.

[4] *Science*, March 3, 1896, *3*, 436.

[5] W. C. Roentgen and the Discovery of the Roentgen Rays. Julius Springer, Berlin. In press.

husband had published his paper. Every day I must admire anew his enormous capacity for work and how he keeps his thoughts together in spite of the thousand and one small things with which he is annoyed. It is however high time now that he should take a rest and I am preparing everything for a few weeks trip to the south where he can spend some time in the open. We are of course grateful that we are privileged to enjoy these wonderful times. How much recognition my husband gets for his untiring researches! Sometimes it would seem that all the praise and honors would make a person dizzy. It would be serious indeed if the man thus honored were conceited. You know my good husband very well and you surely can realize that his greatest recompensation lies in the fact that he could find something valuable in the field of pure science.

A few days after this letter was written Roentgen and his wife started on their trip south. They spent several restful weeks in beautiful Sorrento near Naples, where they stayed at the Hotel Victoria, and there Roentgen found his well-deserved rest. While he was in Italy he saw a note in the papers to the effect that "Prof. Roentgen the famous discoverer of the Roentgen rays was in Italy and had been seen in Rome in a dark brown suit." He immediately packed that brown suit at the bottom of his trunk because he was very shy, and did not want to be famous. He always tried to avoid publicity.

Upon his return from his vacation he continued to work on the x-rays throughout the year. The results of his investigations were published on March 10, 1897, under the title: "Further Observations on the Properties of the X-rays." This work rounded out his fundamental series of experiments on the x-rays.

After the news of Roentgen's discovery had been published, the general public wanted to know more about the man who was successful in opening the door to new wonderlands of science. Naturally the first newspaper accounts of Roentgen himself were rather meager. His name was misspelled "Routgen" through an error in transcription and was reprinted incorrectly in most of the early reports. He was said to be an Austrian professor and the place of the discovery was given as Vienna; this error was probably due to the fact that the first published news of the discovery came from Vienna, as has been previously explained. Soon, however, the clever reporters were able to find out more about his personal affairs and presented their readers with rather good biographies of the great scientist.

Fig. 6. Photograph of Roentgen as a young student.

Wilhelm Conrad Roentgen was born on March 27, 1845, in Lennep, a little town on the Lower Rhine in the heart of the industrial section of that part of Germany. His father, Friedrich Conrad Roentgen, a manufacturer and cloth merchant, had also been born in Lennep on January 11, 1801. The Roentgens came from an old Rhenish merchant family which can be traced back to the seventeenth century. Roentgen's mother, Charlotte Constance Frowein, was

born in Amsterdam on February 25, 1806. She came from a Dutch family well known in industrial and shipping circles. Her father also was born in Lennep. Two of Roentgen's grandparents were cousins. Mrs. Roentgen's mother, Sussanna Marie Moyet, had also been born in Amsterdam. Her family originally came from Italy and emigrated to Holland in the seventeenth century.

Fig. 7. W. C. Roentgen with his parents and other relatives. (Courtesy of the Physical Institute of the University of Würzburg, Director Prof. Dr. Harms.)

Wilhelm Roentgen was an only child, although his father and his grandfathers came from families of many children. Young Roentgen grew up in very happy surroundings. His mother had brought beautiful furniture, pictures, and china, from Holland to their Lennep home and the boy early acquired a taste for art and beauty which he never lost throughout his life. Part of his childhood was spent in Holland with his mother's relatives in Utrecht and Apeldoorn. Later the Roentgens moved to Apeldoorn and their son attended the schools in Utrecht. He was not a particularly brilliant student, always preferring a hike through the fields and woods to dull and uninteresting lessons at school. His happy school days were suddenly interrupted. After a harmless student prank he was found to be guilty and since he did not wish to divulge the names of his accomplices he was expelled from the school. This was a severe blow to his ambitions. However, a great consolation in those dark days was the complete understanding of his beloved mother. He entered the school for machinists in Apeldoorn in order to prepare himself for the profession of his father. A little later he tried again to pass the examinations which would have given him

the same credits as would graduation from the Utrecht school, that is, the right to enter college, but he failed and again had to return to the Apeldoorn school. It is doubtful whether these repeated attempts of fate to bar Roentgen from the regular scholastic courses were really a disadvantage. It would seem that freedom from the strict and often dry scholastic burden permitted the budding genius to develop along lines that later bore the finest of fruit. As often happens a happy coincidence threw new light into the darkness of young Roentgen's student experiences. A Swiss friend of the Roentgens, by the name of Thormann, told the young student that the Zurich Technical High School accepted students for matriculation without the usual credentials. So in the Spring of 1865 we find Roentgen in the beautiful city on blue Lake Zurich and on the road which led him to the highest peak of academic honors. The well known Clausius, Professor of Theoretical Physics, and Kundt, the experimental physicist, awakened such a love for the physical sciences in the heart of the young student that he soon devoted himself entirely to this subject. His brilliant career subsequent to this time is so well known that we will only cite a few of the important incidents of his life.

On June 22, 1869, he was graduated as Doctor of Philosophy and remained as assistant to his teacher, Kundt. Two years later he followed Kundt to Würzburg where the former had accepted the offer of the chair of physics. In Würzburg the two were forced to work under rather unfavorable circumstances in a poorly equipped "physical cabinet." While in Würzburg Roentgen married (on July 7, 1872) Bertha Ludwig, of Zurich, with whom he lived very happily for nearly fifty years. The Roentgens had no children but later adopted and raised a young niece of Mrs. Roentgen.

Once more a dark cloud crossed Roentgen's path. Since he had not the required credentials from Utrecht, the strict old traditions of the Würzburg University would not permit him to become "Privatdozent" and thus to reach the first step of his academic career. However, at that time Kundt was called to the newly-founded German University in Strassburg and Roentgen went with him. Here in the newly-acquired Provinces was an atmosphere free from hampering traditions and after a short time (on March 13, 1874) Roentgen became Privatdozent of Physics at the Strassburg University. A year later (April 1, 1875) he was offered the chair of physics and mathematics at the Academy of Hohenheim which he accepted. However, as he was accustomed to the rather large and well-equipped laboratories of the University at Strassburg he did not feel very happy in the poorly equipped institute at the Hohenheim Academy. At Kundt's request he returned to Strassburg a year later and accepted the Associate Professorship of Theoretical Physics. Alone and also in collaboration with his teacher he published a series of excellent treatises on the merit of which he was offered the chair of physics at the Giessen University. He accepted this appointment on April 10, 1879, and stayed for almost ten years in the old Hessian city. Many of his most valuable researches were carried on in Giessen and here he spent some of his happiest hours and made some of his best friends. In later years he often recalled his pleasant trips from Giessen to the Rhine at the season of the wine festivals.

In 1888 Roentgen was called to the University of Würzburg, the institution which a few years previously had refused to give him his academic standing. Here he succeeded the brilliant Kohlrausch who had gone to Strassburg. It was in Würzburg that he made the discovery of the x-rays in November, 1895.

We have already spoken of the many honors and compliments which were showered upon Roentgen after his discovery. Various institutes made efforts to obtain his services but he stayed in Würzburg until April 1, 1900, when he accepted the call of the University of Munich and moved to the Bavarian capital by special request of the Bavarian government. In 1901 he

was awarded the first Nobel prize. The years in Munich were filled with successful work and happy vacations. When the world war broke out times changed and Roentgen, who always loved his Fatherland, suffered from the hardships of the great conflict. In his loyalty he gave his gold and some of his valuable honorary medals to the government. The tragic results of the war weighed very heavily upon him and his hopes that the broken morale of the German people could ever be regained were almost gone. His beloved wife died on October 31, 1919, after a long illness and Roentgen was a very lonely and unhappy man. He died in Munich on February 20, 1923, of carcinoma of the intestines at the age of seventy-eight years, and his ashes were laid to rest in Giessen. His name and his work will live forever.

Vol. XXV, No. 4

A NEW TRANSPARENT TARGET ROENTGEN-RAY TUBE

By DIMITRY E. OLSHEVSKY
Research Fellow, Sloane Physics Laboratory, Yale University
NEW HAVEN, CONNECTICUT

ROENTGEN rays are usually produced by stopping a beam of electrons at the surface of a solid, the so-called "target." These roentgen rays emerge in all directions. Some of them penetrate into and through the target, essentially in the direction of the impinging electron beam, as transmitted radiation. Some are "reflected" from the surface of the target, back towards the electron source (Fig. 1).

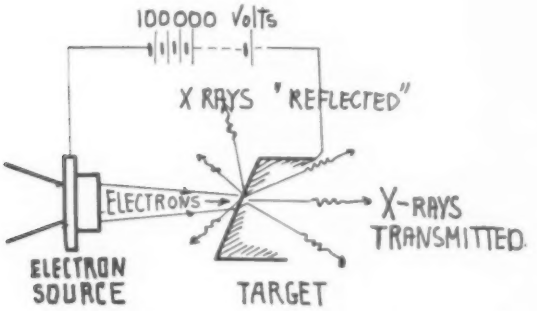


FIG. 1. Illustrating the mechanism of roentgen-ray production and distribution.

Two essentially different types of roentgen tubes are thus possible: Those utilizing the reflected portion of the radiation—operating on the reflecting target principle; and those using the transmitted rays—operating on the transparent target principle.

When, at the end of the nineteenth century, Roentgen obtained his first bundle of x-rays that startled the scientific world, he was actually operating a transparent target x-ray tube. A very inefficient target indeed, for it was formed simply by the glass walls of a cathode-ray tube. The glass had a low melting point and poor heat conductivity. Fortunately enough, it possessed sufficient x-ray transparency to permit the first x-rays to be detected and observed.

Swinton and Campbell tried to improve the roentgen tube by producing the stoppage of electrons at the surface of a platinum button placed within the glass bulb, approximately at its center, at an angle with the electron beam. The high melting point and efficient stopping power of platinum gave to this arrangement, from the very start, a number of decisive advantages over the original roentgen tube. It thus happened that later improvements—as introduction of tungsten for target material of thermionic emission as source of electrons, and so on—were almost exclusively favoring this (now conventional) reflecting target principle.

It seems that only two attempts were made to revive the transparent target principle, by Owen in 1912 and by Coolidge in 1917. The tubes, however, could not compete with the existing conventional models.

We shall later see that the small success of these tubes was due, mainly, to two causes: a poor vacuum technique existing at the time, and the use of a thin, single layer transparent target, instead of a combination of several metals with separate functions. A transparent target, to work efficiently must perform three main functions: It must efficiently stop the electron beam, to convert more of its kinetic energy into roentgen radiation. This is accomplished by using a high atomic number element for the purpose. Theoretically, uranium (atomic number 92) is the best material, although tungsten (atomic number 74) is yet more practicable on account of its high melting point and high heat conductivity.

The transparent target must be transparent, that is, it must transmit roentgen rays without an undue absorption loss. That really means a very thin layer of any of the efficient electron-stopping materials

because an efficient electron-stopping material is, even in a much higher degree, an efficient roentgen-ray absorber.

Now the third condition, that of good heat dissipation, implies a rather thick layer of a highly heat conductive metal.

The way to fulfill all these requirements *simultaneously* is to use a thin layer of high atomic number metal in heat transfer relation with a thicker layer of low atomic number metal (low atomic number metals are very transparent for roentgen radiation) having a high heat conductivity.

It is apparent that the "transparent target" tube has certain valuable advantages over the reflecting target tube. The spot of roentgen-ray generation is close to the outer surface of the tube. This facilitates focusing and definition of the beam. Also, the intensity of the roentgen rays in the direction of the electron beam is somewhat larger than that directed toward the source of electrons. Finally, greater safety is made possible by completely armoring the tube proper and excluding any holes in the tube shield. The low atomic weight layer of the target represents an efficient and absolutely foolproof safety filter.

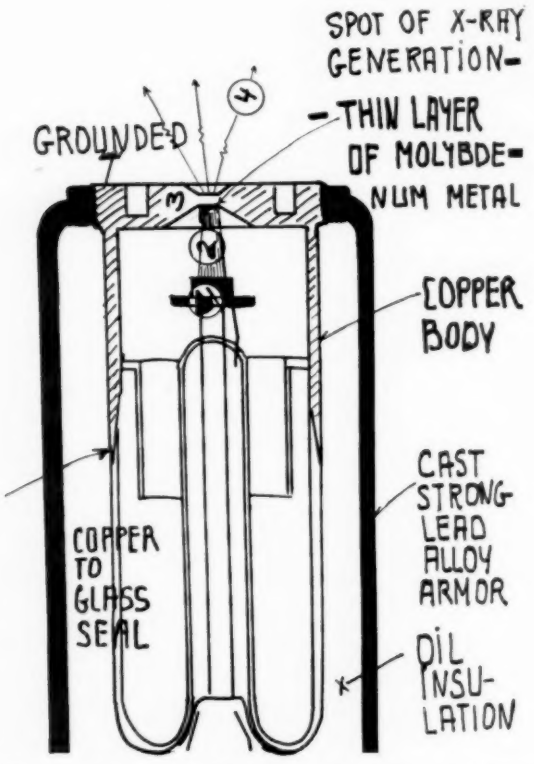


Fig. 2. A design of the new transparent target roentgen tube.

Fig. 3. One of the new transparent target roentgen tubes developed at Sloane Physics Laboratory, Yale University.

From the roentgen-ray engineering standpoint, however, the construction of a transparent target tube presents certain difficulties which should not be underestimated. While no absorbing layers of target metal are in the way in case of the reflecting target arrangement, the transparent target must be built so as to efficiently perform all the duties of the reflecting target plus the transmission of rays. There is also the problem of outgassing a larger metal surface of the anode and a larger metal to glass seal must ordinarily

be made. These last problems are now well within the possibilities of modern vacuum technique. The first problem has been solved in the present design by the utilization of a comparatively thick, double layer target.

In the new tube (Fig. 2) the target consists of two layers of metals with essentially separate functions. The layer facing the beam is a very thin sheet of an element having a high atomic number, high melting and boiling point (tungsten, for example). Its duty is to efficiently produce roentgen rays. This layer is backed by a thicker layer of an element having a low atomic number and high heat conductivity (copper, for example). Its duty is to transmit the roentgen rays and to dissipate heat to the body of the tube where it can be further carried away by a water-cooling or radiator arrangement.

It is hoped that the tube (Fig. 3) will prove of great value for medical purposes. It possesses remarkable safety features both from the roentgen-ray and electrical standpoint. These are due to complete shielding, perfect localization of the beam and automatic safety filtering. On account of axial symmetry of the tube it is particularly useful in vertical arrangement. The tube is placed either below or above the patient with the roentgen beam emerging vertically from the central window at the top (or "bottom") of the tube, along its axis.

The design is particularly suitable for the oil-immersed or transformer-in-shield arrangement. In any case, superior safety is the result of the grounded shielding and the outstanding compactness of design.

With the new tube perfectly localized narrow beams of roentgen rays having greater intensities can be produced, for purposes of deep therapy.

Practically all present super-voltage designs are very naturally adaptable to the new transparent target tube.

THE CAVITY IN PULMONARY TUBERCULOSIS

II. GENESIS AND FURTHER DEVELOPMENTS

By MAX PINNER, M.D., *and* MARIAN E. PARKER, M.D.

From the Wm. H. Maybury Sanatorium
(Detroit Municipal Tuberculosis Sanatorium)
NORTHVILLE, MICHIGAN

THE great majority of phthisiotherapists agree that an essential factor in the active treatment of pulmonary tuberculosis is centered on the attempt to close cavities. The dogma of the grave prognostic significance of cavities is not shaken by any number of case reports of spontaneous closures, or closures under bed rest and some form of "specific" treatment. Case reports, even though they be frequent, attest the rarity of the reported observations; and all statistical presentations on this topic prove the relatively brief average survival period of cavity bearers, and the rarity of closure of cavities without surgical intervention.

The immunological orientation in phthisiotherapy has had its swing, and our sanatoria are still populated with patients, who under the sheltered condition of sanatorium life, show "excellent resistance" to the disease, and are in "splendid general condition," gaining weight and are "practically free of symptoms." In fact, they would not be considered patients at all were it not for positive sputum and roentgenograms which belie the optimistic outward appearance. No other observation carries more convincing proof of the justification of Ranke's concept, that at a certain stage of the disease, phthisis is a strictly localized destructive process in an otherwise little affected body. But this relatively asymptomatic phthisis, or this "compensated phthisis," as it is termed by Sahli, is far from a clinical and anatomical cure. The localized destruction, existing or even progressing in a patient whose general condition is satisfactory, demonstrates at once that "immunity" or "resistance" tells only part of the story. The other part must be read from the localized process. Here, instead of the lofty concepts of immunity, such banal, but substantial factors as loss of tissue, elastic tension, adhesions, fibrosed cavity walls, drainage, bronchogenic spread, erosion of blood vessels, thickened pleura, and so forth, must be reckoned with. In other words, a cavity is largely a mechanical problem; it must be seen as such, and for its healing, the mechanical conditions must be adjusted in such a way as to make healing possible. There is no doubt that fibrosis is one of the most important "healing processes"; fibrosis in a cavity wall may, by the natural retraction of new-formed connective tissue, bring the walls in apposition and finally close the antrum. But in another cavity—the great majority, as experience teaches—the same fibrosis cannot close the antrum because the eccentric tension of the surrounding lung tissue, or the stiffness of pleura and mediastinal structures, does not allow the antrum to shrink, and the progressive fibrosis, instead of closing the cavity, forms a stiff and non-collapsible wall and, by virtue of this fibrosed wall, makes an organized and permanent cavity out of the initial loss of tissue. Only a reduction of the volume of the affected lung, be it by reduction in the size of the hemithorax or by reduction of the lung volume itself, will allow the cavity to contract; and when the fibrosis in the wall is well established, only localized positive pressure is capable of closing the antrum.

In the selection of therapeutic procedures, and in determining the most appropriate time for their use, the histological structure of the cavity wall and its surrounding tissue must be considered. The necessity of differential indication calls for differential diagnosis; this need is the justification for a classification of cavities ac-

cording to roentgenologically recognizable histological characteristics.

Such a classification was suggested in 1928. Three roentgenological-histological types of cavities were distinguished.[2]

The first type, according to roentgenological parlance is described as "*moth-eaten areas in infiltrated parenchyma.*" Frequent autoptic controls have shown that this appearance is due to small multiple cavities, hardly exceeding the size of a cherry pit, which are surrounded by exudative tuberculous processes. Such lesions may be restricted to relatively small areas, they may occupy a whole lobe, or a whole lung. The density of the infiltration increases with its extent. Histologically, the individual cavity represents a loss of tissue in an area of tuberculous pneumonia. The pneumonic process, in these cases, shows the characteristics of William Snow Miller's bronchopneumonia, Type I, *i.e.*, there is no increase of reticulum fibers. It should be particularly emphasized that there is nothing that could be termed a cavity wall; there are no reticulum or connective tissue fibers surrounding the antrum. In the surrounding tissue, the elastic and reticular structure of the parenchyma are well preserved; the alveoli, and frequently the smallest air ducts, are filled with a more or less caseated exudate. The blood vessels are frequently thrombosed, but proliferative changes in the intima and adventitia, which are so common in chronic tuberculous lesions, are usually absent. In the cavity itself innumerable tubercle bacilli are seen.

The second type, "*the round or oval cavities*," appears on the roentgenogram as annular shadows of smooth outline. The shadow itself is a perfect circle or oval without marked distortion from the regular geometrical shape. Its size varies from 1 cm. in diameter to about 10 cm.; this size is rarely exceeded. The density of the ring shadow may be that of a barely visible thin line, it may have the hardness and somewhat stringy appearance, customarily interpreted as fibrosis, or it may present the fairly even, moderate density of an exudative lesion; in this latter case, it will be observed generally that the shadow has blurred outlines against the surrounding parenchyma, another characteristic of exudative foci. Anatomico-histologically, this type of cavity represents a loss of tissue due to an exudative lesion, but in contradistinction to the first type, these cavities are enclosed by a new-formed cavity wall, consisting of a thin layer of concentrically arranged young connective tissue fibers. They, apparently with the eccentric tension of the surrounding pulmonary parenchyma, insure the regular outline of these cavities. Cavity walls with older and denser fibrosis cast denser and more stringy shadows. When a thin fibrous wall is surrounded by a zone of infiltrated parenchyma, the broad, soft, and blurred shadow, mentioned above is produced. This circumfocal infiltration may consist of a fibrino-cellular exudate and promptly be absorbed; in other cases, the exudate is caseated, and then the further development will show a rapid increase of the antrum. The pleura over such cavities is usually not more than slightly thickened.

The third type, the fibrotic irregular cavities, is characterized roentgenologically by their irregular, distorted shape, and by the dense and usually fairly broad shadow which surrounds the hypertranslucent area. Frequently much of the detail is obscured by diffuse pleural shadows. The most important anatomical characteristic is the white line or band of scar tissue which is imbedded in the wall and which can usually be traced into the ridges and trabeculations which emphasize so frequently the irregularity of shape which these cavities present. Usually the inner surface is covered by a well-marked layer of necrotic tissue. Histologically the band of scar tissue consists of a thick layer of interwoven connective tissue fibers, frequently hyalinized, and always poor in nuclei. The arrangement of these fibers is much less regular than in the preceding type; the thickness of this fibrotic layer varies considerably within the same cavity. Three factors

Fig. 1. Roentgenogram taken on January 24, 1927.

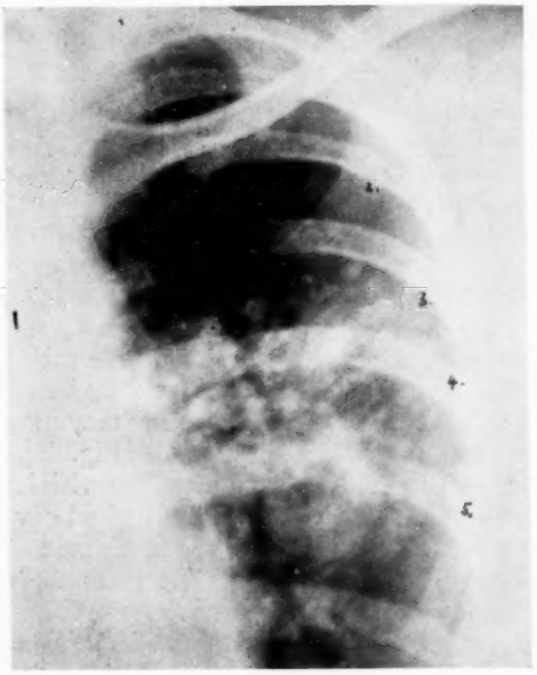


Fig. 2. Same patient as shown in Figure 1—March 23, 1927.

explain adequately the distorted shape of these antra: (1) the traction exerted by contracting scar tissue; (2) the fact that the fibrotic tissue is regularly more luxurious at the site of normal, preformed connective tissue (perivascular, peribronchial spaces, and septa), and (3) the constant marked fibrotic thickening of the overlying pleura, from which the fibrosis extends usually into the septa which join the fibrotic layer in the cavity wall proper. This type of cavity is found in the extreme apices with a much greater regularity than the first two types.

In our first report,[2] the roentgenological appearance of cavities was interpreted in pathological terms; in this report we wish to draw attention to the mode of development of cavities. Only the roentgenological features will be discussed and illustrated, although the type of changes reported here have been checked amply by anatomico-histological observations.

1. *Genesis and Further Developments of the "Round Cavity."* Observation of numerous serial roentgenograms shows convincingly that every "round cavity" is preceded by an infiltrative lesion. This is completely consistent with the anatomical characteristics of these antra. In Figure 1 is shown a rather diffuse infiltrative lesion occupying the second to fourth intercostal space, with a roundish area of greater density in the third interspace. Exactly three months later (Fig. 2) this area is more accentuated and shows a definite central rarefaction. The broad "wall" around the central rarefaction shows all the characteristics of an exudative lesion. This second figure is, then, a very characteristic representative of a quite young "round cavity" with massive circumfocal infiltration. While at the time of the first roentgenogram the sputum was negative, it was strongly positive, though scant in amount, at the time of the second film.

Figure 3 shows a fairly dense infiltrative lesion at the level of the first rib and the clavicle; four and a half months later (Fig. 4) the same area is occupied by a well-defined "annular shadow" whose border is sharply defined both towards the antrum

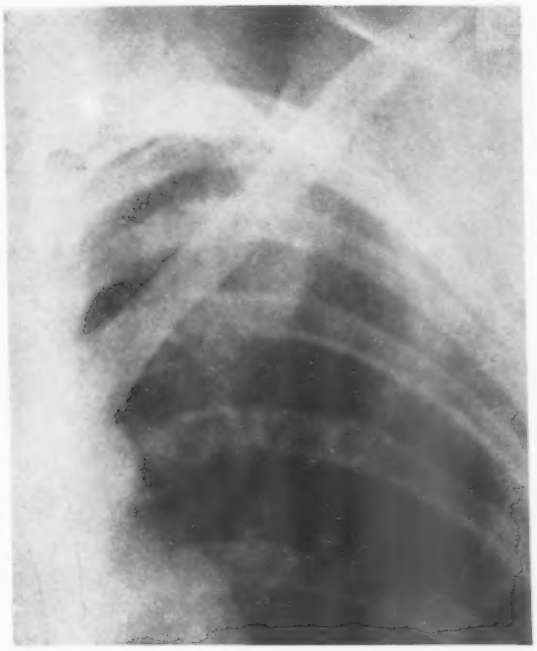


Fig. 3. Roentgenogram taken on May 26, 1927.

Fig. 4. Same patient as shown in Figure 3—October 15, 1927.

and towards the surrounding parenchyma. The impression is gained that in this case the elimination of the diseased tissue has been much more complete than in the former patient.

In Figure 5 is shown an excellent example of an isolated "round cavity" with a very thin but distinct wall. The very rapid changes—both enlargement and closure—which are so frequently observed in this particular type of cavity gave rise to the various theories which attempted to explain them as due to other pathological changes than cavities—theories which now are hardly mentioned by their respective authors. These rapid changes and their almost perfect spherical shape are adequately explained by the assumption that the actual loss of tissue represented by such ring shadows is much smaller than the size of the rarefied area would indicate, and that the elastic tension of the surrounding pulmonary tissue causes the exaggerated size and stabilizes the nearly geometrical regularity of their shape. This contention is

Fig. 5. Representative example of an isolated "round cavity."

Fig. 6. Roentgenogram taken on November 29, 1927.

Fig. 7. Same patient as shown in Figure 6—May 14, 1930.

nicely illustrated by Figure 6. Here is a cavity at the level of the clavicle; its shape is neatly oval with the exception of its lateral part which is formed by a straight border. This flattening is undoubtedly due to two fibrous bands which can be clearly seen to run from the upper and lower pole of the cavity to the lateral chest wall, eliminating the elastic traction of the pulmonary tissue between the points of attachment. The next roentgenogram (Fig. 7) shows the condition of the cavity two and a half years later. The antrum has migrated upward about one interspace, it is shrunken to about one-half its former size, its wall shows dense and hard shadows and the whole apical field shows the unmistakable evidence of fibrotic changes in the pleura. In the meantime, the patient's sputum has decreased from 5 ounces to 1 ounce per day. The cavity is now surrounded by a thick fibrotic wall which merges with the diffuse fibrosis of the surrounding pulmonary and pleural tissue. It is undoubtedly due to the normal shrinkage of the scar tissue, surrounding the cavum in concentric fibers, that the diameter has been so markedly decreased. The same process must have been, in part, instrumental in causing the upward migration; this was assisted by the retraction of the diffuse pulmonary and pleural fibrosis. It must be assumed that, in the present state, there are essentially two forces at work: (1) the scar retraction of the diffuse fibrotic tissue, which, as far as it is attached to circular fibers of the cavity wall, exerts a centrifugal traction, tending to increase the size of the antrum, and (2) the scar shrinkage exerted by the concentric fibers in the cavity wall, tending to diminish the size of the cavum. The hole in the involved area can evidently close only if the volume of the total area is decreased. The forces at work which might achieve this aim are manifested clinically by the visible and palpable retractions of the chest wall, roentgenologically by a narrowing of the pulmonic field and by the upward migration of the lower level of the involved area. But at the stage presented in Figure

Fig. 8. Roentgenogram taken on June 9, 1928.

Fig. 9. Same patient as shown in Figure 8—August 15, 1929.

7, the impression is gained that the maximal effect is obtained, that further shrinkage of the whole area is prevented by the fibrotic stiffening of pleura and mediastinal membranes. Furthermore, as pointed out above, the two forces of scar retraction at play tend to neutralize each other. What is the clinical significance of the cavity at this point? That the cavity has a fibrotic wall is beyond any possible doubt; it may quite likely be one of those thick walls in which the hyalinized fibrosis gives slight, if any, chance for bacterial or decomposition products to enter into the general circulation from the focus of disease. The patient (as was the case in this specific example) may therefore be free of fever, and even of any constitutional symptoms; he has reached the stage of "compensated phthisis." As far as his general condition is concerned, his cavity may be considered as a cavum in a foreign body drained by the bronchial tree. But the shadow in this over-optimistically drawn picture, is the fact that the inner surface of the cavity still contains actively diseased tissue—and tubercle bacilli. There is no justification in the expectation that the drainage of the cavity will always proceed faultlessly in the desired direction. On the contrary, experience has established the fact that sooner or later, instead of efficient drainage, bronchogenic spread is likely to occur.

Figures 8 and 9 show a development similar to that shown in the preceding roentgenograms. The time elapsed between the two figures is fourteen months. The changes which occurred during this period are not so radical as in the preceding example. The oval cavity (Fig. 8) with moderate circumfocal infiltration, especially around its inferior and lateral walls, has migrated upwards one interspace, its largest diameter has decreased to less than one-half and the wall shows definite stringy and linear shadows, indicating increased fibrosis. At the same time, the apical field which showed no fibrosis in Figure 8, shows definite involvement in Figure 9. It has been pointed out that apical involvement, in

Fig. 10. Roentgenogram taken on June 6, 1927.

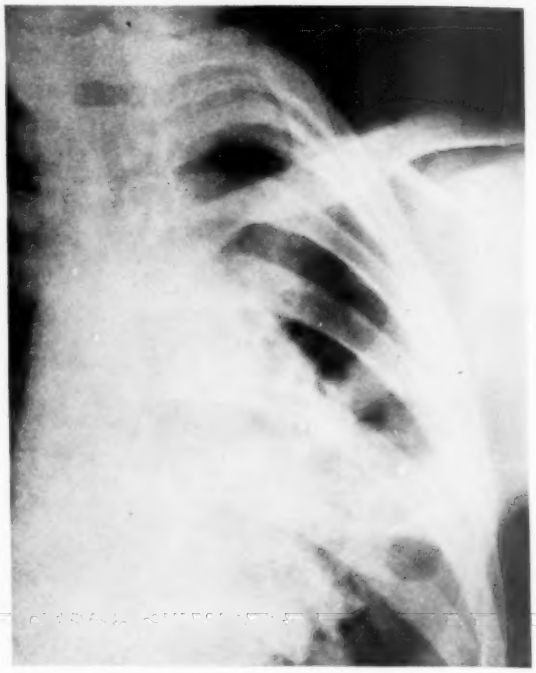


Fig. 11. Same patient as shown in Figure 10—June 14, 1928.

many cases, is a late, and not, as customarily interpreted, an early occurrence.

2. "*Small Multiple Cavities.*" Figure 10 is a representative example of what has been described as "moth-eaten areas in densely infiltrated pulmonary tissue." The correct anatomical interpretation of such roentgenological shadows is not always simple. If such lesions occupy a considerable portion of the lung, the lung field is not infrequently narrowed, the intercostal spaces are narrow, and the mediastinal structures may be deviated slightly towards the involved side. All these factors are unexplainable on the assumption of a simple infiltrative lesion. Although consistent anatomical proof is lacking, it is probably safe to suppose that hand in hand with parenchymal infiltration, there exists a certain degree of atelectasis which would explain the points mentioned above. It would explain, too, how in some of these lesions an astounding amount of "clearing by resolution" is observed. A differential roentgenological diagnosis between the factor of tuberculous infiltration and the factor of atelectasis, which combine to produce the dense and diffuse shadows, seems to be impossible, unless one attempts to base it on the circumstantial evidence of such secondary changes which atelectasis is known to cause. With this uncertainty in the interpretation of this type of roentgenological pictures, prognostication is rather uncertain. As mentioned, some of these lesions show remarkable clearing, suggesting the likelihood that a considerable part of the shadow was caused by atelectasis. Others show extensive, and at times rapid, destruction. This is the chain of events in the present example. In the course of one year, the entire infiltrated area has excavated, while infiltrative lesions are still burrowing downward into the parenchyma (Fig. 11). If the involved area is small, moth-eaten areas in infiltrated parenchyma result not infrequently in isolated round or oval cavities; but if the involvement approximates lobar extension, large, saccular (not infrequently lobar) excavations result typically. The prognosis of such cavities, as far as

Fig. 12. Large saccular cavity, resembling pneumothorax.

healing is concerned, is hopeless even with surgical treatment. They are surrounded by a wall which consists of a thin necrotic layer and a—usually but slightly—thickened pleura. Even if against all reasonable expectations a free space could be found, pneumothorax treatment faces the danger of pleural perforation. No other surgical method can reduce the pulmonary volume sufficiently to give any promise of obliteration of such large cavities. In some patients, however, in which such a saccular cavity is the only definite lesion, one is surprised to see how long life is compatible with such enormous defects, and how slight the symptomatology can be under favorable conditions. The extent to which such saccular cavities may develop is well shown in Figure 12, from which it becomes obvious that they may resemble pneumothorax. The differential diagnosis is usually made without difficulty on the basis of history, former roentgenograms, physical signs, and —last not least—by the contour of the cavity. In the present example, the fact that the lower contour points upward with its concavity is the most important roentgenological criterion for the diagnosis of cavity and against the diagnosis of pneumothorax.

COMMENT

The attempt to classify tuberculous cavities according to structural peculiarities which are roentgenologically recognizable is prompted by the desire to give a sound basis for prognostication and therapeutic indication. In differentiating three or four types it must be emphasized that they are pathogenetically not essentially different; they are all the products of the fundamentally well-known tissue alterations which are characteristic of tuberculosis. The interplay of caseation, liquefaction, resorption and fibrosis with the peculiar mechanical conditions existing within the pulmonary parenchyma, accounts for the striking structural differences of cavities at a given time in their development. Although it is the primary aim of this report to point out these differences, it must not be overlooked that they are essentially differences in a developmental cycle and differences in degree. Our studies leave little doubt that almost every cavity is preceded by an exudative lesion, that it is the product of the expulsion of more or less necrotized material. If this process occurs in an isolated focus—and it frequently does in clinical incipiency or at the onset of acute exacerbations—the result is an isolated cavity, round or oval if the evacuation of the caseated material has been fairly complete. If an exudative lesion is massive and if therefore many centers of excavation occur, the "moth-eaten areas" will develop. The individual cavity in this case does not grow as quickly as in the former case, presumably because the expelling forces are impaired by the massive infiltration surrounding the cavity (loss of motion and elasticity). The further developments depend on progressive infiltration and excavation, confluence of multiple foci, and on fibrosis. These processes account in the

case of the isolated round cavity for increase and decrease in size, and for the fibrotic transformation of the wall; in the case of the multiple small cavity, for rapid extension, which in some cases is not even limited by the interlobar pleura.

The classification of cavities, as discussed in this report, has had a practical clinical trial in this Sanatorium and in the Tuberculosis Division of the Herman Kiefer Hospital, Detroit, for the last two years. It was found that almost all cavities can easily be assigned to one of the types described. In support of the clinical usefulness of this classification, a few data may be mentioned which show that the different types of cavities present distinctly different therapeutic indications and different prognosis.

Saley[3] determined in a series of 31 cavity bearers, the collapsibility of cavities under artificial pneumothorax treatment. His results are shown in Table I.

Table I

Type of Cavities	No.	Closed
		per cent
Small, multiple	5	100
Round or oval, isolated	22	63.6
Fibrotic	4	0

Werner and O'Brien[4] studied the fate of cavities in 100 patients treated by bed rest only, over a period of three years, and in 100 patients treated by phrenicectomy. Table II summarizes their results.

O'Brien[1] reported his results on cavities following phrenicectomy. Table III is taken from his paper.

Table III

Type of Cavities	No.	Closed	
		No.	Per cent
Small, multiple	56	51	90.0
Thin-walled	238	134	58.8
Thick-walled	84	6	7.1

All three tables show that therapeutic results are readily obtained in an encouraging percentage of the small, multiple cavities and of the round isolated cavity, and that the fibrotic cavity is a rather hopeless problem, as far as closure is concerned. Werner's study showed that even after phrenicectomy the fibrotic cavity manifests its stability by not noticeably changing in size in 38 per cent. On the other hand, the cavity which is not yet invested with a fibrotic mantle increases in size more frequently than the fibrotic cavity, if not treated surgically.

It is evident from the foregoing discussion, that the small, multiple cavities of moth-eaten appearance, and the round or oval cavities are, in terms of pathogenesis, *young cavities*, while the thick-walled, fibrotic cavities are *old*. In Table IV all young cavities and all old cavities are added from the three foregoing tables, and their respective percentage of closure under surgical treatment (pneumothorax or phrenicectomy) is calculated.

Table II

Type of Cavities	No. of Cases	Treated without Surgery Cavities			No. of Cases	Treated with Phrenicectomy Cavities		
		Larger	Decreased	Closed		Larger	Decreased	Closed
		per cent	per cent	per cent		per cent	per cent	per cent
Small, multiple	0	0	0	0	12	0	0	100
Round or oval, isolated	66	69.7	12.1	18.1	67	4.4	38.8	55.2
Fibrotic	34	44.0	50.0	5.8	21	19.0	42.8	0

Table IV

Type of Cavities		No.	Closed following Pneumothorax or Phrenicectomy	
			No.	Per cent
Young:	Small, multiple Round, isolated	400	253	63.3
Old:	Thick-walled Fibrotic	109	6	5.5

The conclusions that must be drawn from Table IV are so obvious that they need not be discussed. Since it is quite customary to report the size and the localization of cavities, it can hardly be overemphasized that a roentgenological report indicating the structural peculiarities of cavity walls is of no less practical importance. More than localization, and certainly more than size—within limits—it is the anatomical nature of the cavity wall which decides curability and choice of therapeutic methods. As was shown in two examples, the shrinkage of a cavity is not necessarily a promise of satisfactory future developments. If it is a shrinking with a large amount of fibrosis, it is likely to produce those cavities which offer the most difficult therapeutic problems. The decrease in size of a cavity does not *per se* indicate future closure; it should not prevent active treatment which is otherwise desirable. The fibrotic wall which—in some regards—protects the body from the focus it encloses, at the same time protects the cavum from obliteration.

It is not the aim of these studies to subdivide the clinical and pathological entity "cavitation" into various phases of development and into distinctly different types. It must be obvious from the preceding discussion, that the different roentgenological appearances of cavities are due to a continually flowing process in the development of pulmonary tuberculosis, and the dividing lines between different roentgenological "forms" are by necessity arbitrary and indistinct. It is a continuous metamorphosis which changes the characteristic round, thin-walled, young cavity into the fibrotic, old cavity. But the fact that both prognosis and therapeutic response are so markedly different in the three types of antra which have been described should justify the attempt to recognize them properly as a basis for therapeutic indication. The practically significant conclusions from our studies may be summarized by saying that therapeutic success by surgical treatment of cavities is obtained in a percentage which is in inverse proportion to the amount of demonstrable fibrosis in the cavity wall; that the amount of fibrosis can be judged fairly accurately by the roentgenological appearance, and that this criterion should be most carefully considered in therapeutic indication.

CONCLUSIONS

The roentgenologically recognizable anatomical structure of cavities in pulmonary tuberculosis is, in regard to therapeutic indications and prognostication, a vastly more important factor than localization, and than—within certain limits—size.

The classification of cavities discussed is essentially based on the factor of fibrosis which usually increases with the age of the cavity. This classification has been found to be applicable to practical clinical work.

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A DISCUSSION OF THE OCCURRENCE OF BENIGN ULCER ON THE GREATER CURVATURE*

By JOHN SPROULL, M.D.
HAVERHILL, MASSACHUSETTS

THE study which I am presenting had its origin in a failure of diagnostic interpretation of a roentgen examination, on my part, and a mistake in diagnosis by two surgeons and one pathologist, of a stomach lesion, with the actual lesion in front of them after its operative removal.

An examination of the literature on ulcer of the greater curvature shows a condition of inaccuracy, consisting of inadequacy of evidence upon which cases have been reported as such, and of a multiplicity of lesions which, reported as ulcers on the greater curvature, have proved, on correct classification, to be either something other than peptic ulcers as we understand them, or, in some instances, located not on the greater curvature, but on the anterior or posterior wall. Cases have been reported as ulcer which on histological examination showed adenocarcinoma, mycotic infection of the gastric mucosa, lesions of aleucemic lymphadenosis, and also burns of the stomach produced by the ingestion of strong corrosive solutions—such as 50 per cent solution of chloride of zinc and strong soldering fluid.

In this paper, the term "peptic ulcer" means a benign localized ulcer of the stomach, such as is commonly seen on the lesser curvature, and of which the most definite type is the saddle ulcer. That the term "ulcer" should be limited to this is clear; for in the practice of medicine, ulcer is distinguished from carcinoma by its benignity. A diagnosis of peptic ulcer connotes a benign lesion.

In the literature there are two papers of prominence: one by Finsterer and Glaessner,[3] who reviewed all cases up to 1914, and found 36 cases reported as ulcer on the greater curvature, and the other by David,[2] who reviewed all cases reported from 1914 to 1928. The latter, however, missed some which were in the American literature; notably, three cases diagnosed and reported by Blaine[1] in 1925, and presented before this Society.

CASE REPORT

The case which prompted this investigation was that of a young woman, aged twenty-four, who consulted me on September 25, 1928, with the following history:

Beginning in January, 1928, she had epigastric distress radiating to her left breast. This distress came on two or three hours after eating, and presented periodicity, relief following taking of food and alkalies. She did not consult a physician until May, and then only because the symptom of vomiting the stomach contents every afternoon at about 5 P.M. had occurred. The vomitus consisted of the food eaten at midday, and sour, acrid material. She had never vomited blood or "coffee ground material."

The physician whom she consulted diagnosed her condition as neurosis, and constipation, and advised a laxative.

Not improving under this treatment, she consulted a second physician, who made a diagnosis of probable gastric ulcer, and sent her to a roentgenologist for a gastrointestinal examination. The report was rendered that there was an area of spasm on the greater curvature, but no definite lesion was found. The physician put her on ulcer treatment, with immediate relief of all her symptoms. She gained in weight and felt well.

A month later she was again examined by the same roentgenologist, who again reported the same area of spasm on the greater curvature, and though not definitely sure of an organic lesion, suggested the presence of a benign tumor of the stomach.

She continued the ulcer treatment under the supervision of her physician and made excellent progress.

At the time she consulted me, September 25, 1928 (nine months after the onset of her symp-

* Read at the Thirty-first Annual Meeting, American Roentgen Ray Society, West Baden, Ind., Sept. 23–26, 1930.

toms), she still had slight epigastric distress occasionally, but could eat a very varied and full diet with no ill effects. She had no vomiting, and no disagreeable subjective or objective symptoms.

Examination showed a tall, rather obese young woman of good color, animated, and without any of the usual external evidences of serious disease. The physical examination, including blood, was entirely negative.

Roentgen examination at this time showed a deformity of the greater curvature of the stomach, which, when twice examined on separate days, was constantly present in all positions. Peristalsis did not seem to pass over this deformity and there was some evidence on palpation suggesting the presence of a crater; the note was made in the interpretation that "were this deformity on the lesser curvature, a diagnosis of ulcer would be justifiable."

In view of the doubt of the existence of such a lesion as ulcer of the greater curvature, and because of the long duration of the symptoms with such a small deformity, a diagnosis of benign tumor of the stomach was made and operation advised, but not accepted.

Fig. 1. Appearance of the stomach September, 1928. Note the area of spasm on the greater curvature, in the center of which is a niche-like protrusion. At this time no peristalsis passed over the lesion. There was some evidence suggesting crater formation.

Fig. 2. Appearance of the stomach two months after Figure 1. Note that there is no evident increase in the size of the lesion. At this time peristaltic waves passed freely over the lesion and no evidence of crater formation could be made out.

She came again in November, 1928, for reexamination, and a roentgen examination at this time showed the same condition as in September, with these two exceptions: peristalsis was repeatedly seen to pass over the lesion, and the evidence of crater formation could not be made out.

These findings seemed to favor the diagnosis of benign tumor. Operation was again advised, but again refused.

The patient returned in February, 1929, desirous of having an operation performed, in accordance with the advice previously given. She appeared perfectly well at this time, was in good flesh, of excellent color, and eating a full diet without distress. Roentgen examination at this time confirmed the previous observations, and showed no retrogression or progression of the lesion (an observation of some importance).

She was referred to a surgeon specializing in gastric surgery. Laparotomy revealed a small

Fig. 3. Appearance of the stomach six months later than Figure 1, with which it should be compared. Note that the lesion is of no greater size than in Figure 1.

ulcer lesion exactly on the greater curvature. The next day the following letter was received from the surgeon:

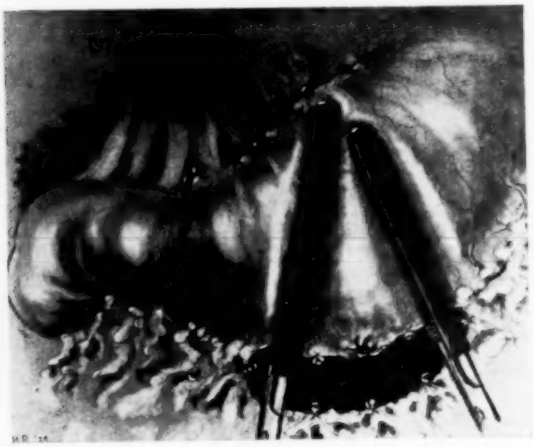

Fig. 4. Reproduction of artist's drawing of stomach at time of operation. Note the very small puckered lesion exactly on the greater curvature between the resection clamps. This lesion is at least thirteen months old.

You will be surprised, as I was, to learn that at the operation on Miss —— this morning we found a definite ulcer on the greater curvature. It did not look like cancer and was not a growth, but was an ulcer with a definite crater. I excised this by taking out a V-shaped piece and then closed the stomach. . . .

On receipt of this letter, consultation was held with the surgeon, and agreement was made to obtain a photograph of the excised lesion, and to have a histological examination and photomicrographs made.

Unfortunately, before the consultation was held, the specimen had already gone to be prepared for section, and so a photograph of the actual lesion could not be obtained. The surgeon's assistant, an artist of some merit, volunteered to make a drawing of the condition found at operation, and this is shown in Figure 4.

Fig. 5. Postoperative appearance of the stomach. Note the site of the resection on the greater curvature.

A week later a second letter was received from the surgeon, which read as follows:

The case of Miss —— has certainly turned out to be the most unusual thing. I told you that it was an ordinary ulcer, and my assistant and I agreed on

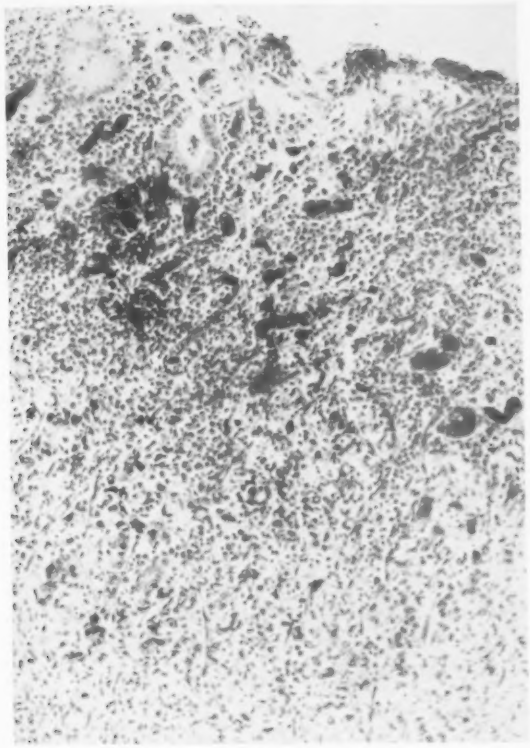

FIG. 6. Low power photomicrograph of histological appearance of the lesion.

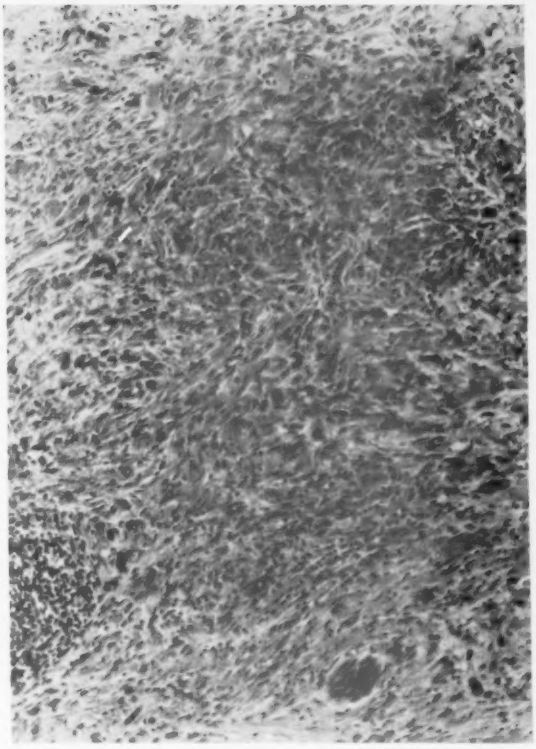

FIG. 7. Medium power photomicrograph of the histological appearance of the lesion.

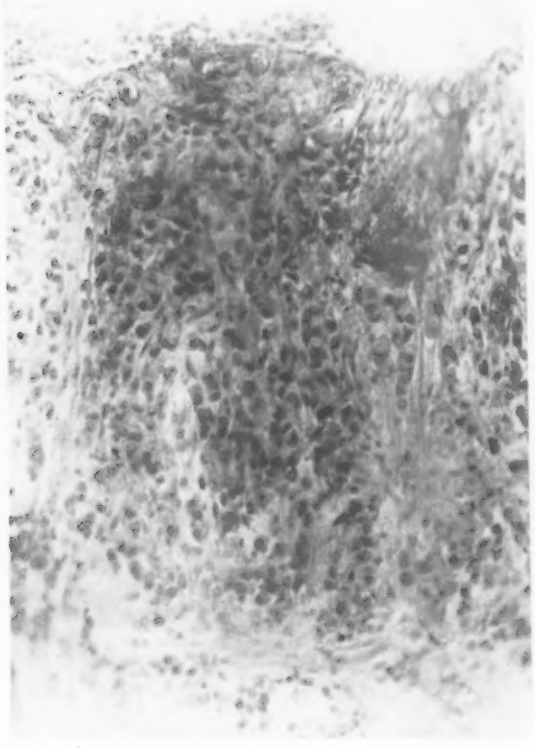

FIG. 8. High power photomicrograph of the histological appearance of the lesion. Note the invading strands of epithelial cells. Many show mitotic figures.

FIG. 9. Appearance of the stomach August 22, 1930. Note the filling defect and niche formation at site of resection. There is evidence of involvement of both curvatures and by palpation at the roentgenoscopic examination a definite crater could be made out. The findings are indicative of recurrence of the carcinoma at the operative site.

this, and the pathologist at the hospital likewise agreed, but on microscopic examination he reversed his diagnosis and called it cancer. The report is as follows:

Specimen consists of a portion of stomach wall, 5.5 cm. in diameter, in the center of which is a crater-like area of ulceration of the mucosa and submucosa, 2 cm. across, with a firm, indurated border.

Microscopic examination: Mucosa has a crater-like area of ulceration with discrete surface margin. The adjacent and underlying mucosal epithelium has lost its normal glandular appearance and, instead, are many clusters and strands of basophilic epithelial cells of mostly large, irregular size, occasionally showing mitotic figures but lacking any definite alveolar arrangement. These small clusters have a fairly abundant fibrous stroma, which includes numerous small capillaries and lymphocytic and slight polymorphonuclear infiltration. Some clusters have invaded the submucosa and inner layer of the muscularis, which, along with the serosa, show fairly abundant fibrosis and lymphocytic infiltration.

Microscopical Diagnosis: Carcinoma simplex (early).

The histological specimen was then submitted to three other pathologists, namely, Dr. Tracy Mallory, Massachusetts General Hospital, Dr. Frank Mallory, Boston City Hospital, and Dr. Parker, Boston City Hospital. All of them agreed on the correctness of the diagnosis of carcinoma simplex (early).

Subsequent Examination. Roentgen examination on August 22, 1930, of the reported case showed recurrence of the carcinoma at the site of the previous resection (see Fig. 9). At exploratory laparotomy, performed on September 4, 1930, an annular carcinoma was found at the site of the previous resection and metastasis to the lymphatic glands. A section of a gland removed showed metastatic carcinoma.

COMMENT

Some of the outstanding features of this case call for special emphasis:

A young woman, twenty-four years of age, with symptoms of stomach trouble for over a year. These symptoms were those of the syndrome usually considered characteristic of ulcer, namely, epigastric distress coming on two to three hours after eating, and showing periodicity, relief after food, and from alkalies. In addition, the patient had shown a symptomatic cure on ulcer treatment. On this treatment she had gained weight, her symptoms had subsided, and she had come to eat an ordinary diet, and was able to work hard without unusual fatigue, and to sleep well.

And again, it should be noted that she had a definite lesion on the greater curvature of her stomach, which, on histological examination, was proved to be carcinoma, and yet this lesion, during a period of at least six months preceding operation, had shown no progression.

It is clearly evident that this case presents some unusual features, and is much at variance with our concept of the usual behavior of gastric carcinoma.

By personal communication with some of the leading roentgenologists, whose combined experience covers several hundred thousand stomach examinations, not one has been found who has had the diagnosis of benign ulcer on the greater curvature of the stomach confirmed by histological examination. All other forms of stomach lesions are being diagnosed by these roentgenologists, and it seems reasonable to assume that, if this location of benign peptic ulcer ever exists, it would have been observed by some of them.

In view of these facts, and the unusual case presented, considerable doubt may well be entertained as to the accuracy of diagnosis of these cases reported in the literature as benign ulcer on the greater curvature of the stomach, even when confirmed by histological examination.

In reviewing the literature from 1914 to 1928, on ulcer occurring on the greater curvature, David found 24 cases reported as such. Examination of these 24 cases showed 41.66 per cent proved by histological examination; 33.33 per cent were not peptic ulcer as I have defined it and as the term is commonly used in medicine; 25 per cent were reported as ulcer without any histological examination.

These figures show that almost 60 per cent of the cases reviewed by that author were either some other disease than peptic ulcer, or were not located on the greater curvature, or were not proved by histological examination.

These percentages, however, do not indicate to a full degree the chaotic condition of the literature. Careful reading of the translation of the original article leaves some doubt as to whether the proved ulcers in several cases did not originate on the posterior wall, and not on the greater curvature. This question of exact location is not made as clear as it should be. This is especially true of several cases of peptic ulcer of considerable size penetrating into the spleen, the benign nature of which was proved by histological examination.

It can readily be seen that it might be difficult or impossible to determine the exact location of the original ulcer with the distorted anatomical relationships incidental to penetration into the spleen.

Not included in these 24 cases reviewed by David were three cases diagnosed and reported by Blaine in 1925.

If the diagnoses of benign ulcer on the greater curvature by this author are correct, he has had an unusual experience. Review of the report of these three cases teaches some valuable lessons:

In Case I, a roentgen diagnosis of a typical penetrating ulcer on the greater curvature was made and confirmed by macroscopical findings at operation. However, no histological examination of the excised specimen was made, and no follow-up of the case was reported, the writer simply stating, "The patient was later discharged from the hospital as cured."

In Cases II and III, the diagnosis was made entirely by roentgen examination, and was not confirmed by operative findings, nor by histological examination, nor by follow-up of either case.

When one considers the fact that in the case which forms the basis of my study, the macroscopical appearances of the excised lesion were such as to deceive two surgeons who specialize in gastric surgery, and a pathologist, a large part of whose activities are confined to the expert diagnosis of cancer, the importance of the histological examination cannot be over-emphasized, and the omission of such an examination invalidates the accuracy of any diagnosis of ulcer on the greater curvature.

The reporting, on such inadequate evidence, of cases of so rare a lesion as benign ulcer on the greater curvature, is unscientific and misleading. In Case I, reported by Blaine, the neglect to have a histological examination of the excised specimen cannot be excused; and a case should not be reported as cured simply because the patient left the hospital alive. The other two cases need hardly be considered, as the findings were not confirmed by operation, nor by a follow-up of the cases. In view of the normal percentage of error in all gastrointestinal roentgen examinations, the presence of any lesion at all in the two cases not operated on or followed up may justifiably be questioned. It seems very necessary to say that, in reporting cases of unusual conditions, the evidence sustaining the diagnosis should be almost incontrovertible, and should be fully set forth in the published report. Because of the lack of histological and other evidence, the three cases above cited should not be classified as ulcer on the greater curvature.

From this study of the literature, and from a study of the case presented, several conclusions may fairly be drawn to guide our future conduct in similar cases.

(1) It is probably unwise for a roentgenologist to diagnose a lesion on the greater curvature as benign peptic ulcer. The chance of the diagnosis being correct is very small—probably one in a million—and making such a diagnosis connotes a benign lesion, and may influence an uninformed practitioner to adopt medical treatment for a lesion which should be treated surgically.

(2) No case of a lesion of the greater curvature should be reported as benign peptic ulcer, without a histological examination of the specimen by more than one pathologist; and in the report should be incorporated the clinical history, the operative findings, roentgen findings, a photograph or drawing of the lesion, and a detailed his-

TABLE I

ANALYSIS OF REPORTED CASES OF BENIGN ULCER ON THE GREATER CURVATURE*

Number in literature up to 1914 (Finsterer and Glaessner[3])	36 cases
Number in literature 1914 to 1928 (David)[2]	24 cases
Number of these 24 cases histologically proved	10 cases (41.66%)
Number of these reported which were not benign ulcer of the greater curvature	8 cases (33.33%)
Number of these 24 cases not histologically proved	6 cases (25%)
(1) Case reported by Finsterer and Glaessner (penetrating ulcer into the spleen)	Histologically proved
(2) Case reported by Groedel and Levi	No post mortem. No histological examination
(3) Two cases reported by Schlesinger	No histological examination
(4) Two cases reported by H. K. Bauer	(*a*) Tuberculous lesion (*b*) Not on the curvature, but was a fungus infection on the anterior wall
(5) Case reported by Kraft	Histologically cancer
(6) Case reported by Timbal	No histological examination
(7) Case reported by Lecher	No histological examination
(8) Case reported by Podlaska	Proved by histological examination
(9) Case reported by Walter, 1924	Proved by histological examination
(10) Two cases reported by Lorenz, 1924	Proved by histological examination
(11) Case reported by Somner. Question of location	Was diagnosed as on greater curvature by roentgen ray. On examination of resected specimen, it was found on the posterior wall
(12) Case reported by Medanic	No histological examination
(13) Case reported by Stohr	Due to child drinking strong soldering fluid. Should be classified as a chemical burn, not an ulcer
(14) Case reported by Dreuschuch, 1927	Was not an ulcer and was not on the greater curvature. Histological examination showed lesion was on the anterior wall and was an adenocarcinoma
(15) Two cases reported by J. Simon	One proved by histological examination; the other not
(16) Case reported by M. P. Raul	Cure through resection. No histological examination
(17) Two cases reported by V. David Neither should be classified as ulcer	(*a*) Followed ingestion of 50 per cent chloride of zinc solution (*b*) Histologically ulcerating lesion of aleucemic lymphadenosis
(18) Two cases reported by F. Sladsky	Proved by histological examination
(19) One case reported by T. Koch and Balaban, 1928. Question of location	Penetrating ulcer of greater curvature into the spleen. Histologically proved
(20) Three cases reported by Blaine[1], 1925. Diagnosis made by roentgen ray	(*a*) Operation. No histological examination. No follow-up (*b*) Roentgen diagnosis. No operation. No follow-up (*c*) Roentgen diagnosis. No operation. No follow-up
(21) In 200 cases of gastric and duodenal ulcer at the University of Prague in the clinic of Charles, the diagnosis was made twice by roentgen ray, but at operation no ulcer was found.	

* All of the cases analyzed, with the exception of (20) are taken from the paper by David.[2]

tological examination with the accompanying photomicrographs.

(3) No lesion of the greater curvature should be treated by medical measures, however small the lesion, or however closely the clinical and the roentgen findings may simulate ulcer, for the chance that it is not ulcer is so great that one will be almost surely missing the opportunity to remove early cancer. The consequent delay, while medical treatment is being tried, may cost the patient his life. The only probable exception to this rule should be where the lesion is associated with general syphilis; and even in this case, since it is a well-known fact that not all lesions in syphilitics are due to syphilis, the wisdom of adopting medical instead of surgical treatment may be questioned.

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DISCUSSION

Dr. H. K. Pancoast, Philadelphia. One cannot but be impressed by the conservative conclusions drawn in Dr. Sproull's admirable presentation of the subject. There is no doubt that benign ulceration of the greater curvature aspect of the stomach does occur. We have encountered but one case of the kind and in that instance made a diagnosis of carcinoma. Biopsy proved the condition to be benign ulceration. We must remember, however, that even the best of pathologists will disagree as to whether carcinoma is present in a gastric ulcer. Some years ago Dr. Gray referred a case to us for an opinion as to whether the man had ulcer or cancer. We were uncertain as he was. The patient went to the Mayo Clinic and Dr. Moore was also uncertain but inclined to ulcer as we all did. Even Dr. MacCarty was unable to state absolutely that the excised specimen did not contain carcinoma, although he was inclined to regard the condition as ulcer. Fortunately the area was excised.

If I were unfortunate enough to have a lesion on the greater curvature aspect of my own stomach which by roentgenological study seemed to be carcinoma but at operation resembled ulcer and on frozen section, ulcer was diagnosed, I would certainly want the radical treatment for cancer.

The greater curvature is such a frequent seat of carcinoma. Benign tumors frequently occur there and are prone to become malignant.

I would like to ask if there is any anatomical reason why the posterior wall is so frequently the seat of ulcer, which is benign, yet the neighboring greater curvature aspect is almost invariably the seat of carcinoma. Of course we know there are reasons why the lesser curvature may be the seat of ulcer more frequently than carcinoma. I am asking particularly of the outlying areas.

Dr. Lewis G. Cole, New York City. I think the Society is to be congratulated on the remarkable Scotch presentation of this subject. The thoroughness with which Dr. Sproull has prepared and presented this paper makes it exceedingly valuable. It is remarkable that a man should take as relatively small and insignificant a subject and search out truths with the degree of persistency that he has in this case. His search has revealed that, in many cases, false findings have been reported where observers have been careless or have made reports on a less thorough examination of facts. I have attempted to run down certain similar reports which I have considered false, particularly those which have been carelessly and thoughtlessly made in articles or, in impromptu discussions, where the speaker has expressed himself without previous preparation and, very often, with the same success that Dr. Sproull had in his cases. Therefore, the Society should be proud of this presentation.

It also emphasizes the fact that, up to three or four years ago, the literature indicated that a relatively large percentage or, at least, a fair percentage of ulcers have occurred on the greater curvature. In one of the textbooks on surgery, you will find a diagrammatic sketch showing the location of ulcers which is so

greatly at variance with the facts that one wonders how such a diagrammatic sketch could have been made. This article, so carefully prepared and published in this way, will emphasize how rarely benign gastric ulcers occur on the greater curvature. Personally, I have diagnosed only two cases of ulcer on the greater curvature and these were both wrong. One of them I saw a year later and when I went back to study the original plates I could not conceive how I could possibly have originally diagnosed this case as an ulcer instead of a cancer. It was a growth that projected into the stomach with a hole in the center of the growth, all of the ear-marks of malignancy, and I had called it an ulcer. The other case was one many years ago, a patient from Boston, upon whom I made a diagnosis of gastric ulcer of the greater curvature. This diagnosis was subsequently reported as correct by surgical exploration but, from a restudy of the full series of plates, I am led to believe that both my diagnosis and the surgeon's statement concerning the location of this ulcer on the greater curvature were incorrect. So much for the commendation of this very excellent paper.

A question which Dr. Pancoast asked was why cancers occur in one region and ulcers in another. These are two questions, two distinctly different questions, and when one tries to answer two distinctly different questions at the same time, he is getting into trouble. I prefer not to refer to the cancer but will refer to the ulcers of the stomach. There is a very definite, almost incontrovertible rationale for ulcers occurring on (not the lesser curvature) but on the anterior or posterior wall so close to the lesser curvature that most of them are thought of and described as being on the lesser curvature, but rarely are they directly on the curvature. They are just off the curvature which is where there is a certain anatomical reason for their being present at that particular point.

Again, the histological structure of the stomach can readily be divided into an ulcer-bearing area and non-ulcer-bearing area and, by microscopic study, one can determine whether the section is from an ulcer-bearing area or from a non-ulcer-bearing area, particularly if these sections are removed from a patient who is susceptible to gastric ulcer. There are essential histological-anatomical characteristics which are present in an ulcer-bearing area which are not present in a non-ulcer-bearing area. These are facts based on pathological findings.

Dr. L. T. LeWald, New York City. Dr. Sproull's last sentence rather interested me, in which he implies that a syphilitic lesion of the stomach might be confused with a lesion such as he observed and that no time should be taken to test the case for response to an antisyphilitic treatment. I think that is a mistake. I would regret very much to see a case have an extensive resection, as so many surgeons would do if they were told that a lesion on the greater curvature, no matter how small, was potentially malignant. They might do a very extensive resection without a frozen section and then the pathologist might return an opinion that there was no evidence of cancer and the patient might succumb to the operation.

Furthermore, the lesion might be found to be definitely syphilitic. I would say that the slight lapse of time would be justified, particularly, as he stated, where the patient gave a syphilitic history, or, a positive Wassermann. Suppose this were a young subject, thirty-five years of age, I am sure that one would be justified in taking three weeks for intensive antisyphilitic treatment, and then study the case roentgenographically to see if the lesion had improved.

Dr. Sproull (closing). In regard to Dr. Pancoast's question, I know no reason and I did not find any reason why ulcer does not occur on the greater curvature. It does occur on the anterior wall and posterior wall, and I know no reason why the greater curvature should be exempt from its invasion.

In regard to Dr. LeWald's remarks, I think Dr. LeWald misunderstood what I said. I said no lesion of the greater curvature should be treated by medical measures, however small the lesion or however closely the clinical and the roentgen findings may simulate ulcer, for the chance that it is not ulcer is so great, that one will be almost surely missing the opportunity to remove early cancer. The consequent delay while medical treatment is being tried may cost the patient's life. The only probable exception to this rule should be where the lesion is associated with general syphilis; and even in this case, since it is a well-known fact that not all lesions in syphilitics are due to syphilis, the wisdom of adopting medical instead of surgical therapy may be questioned. I left the matter open for consideration. It is well known that syphilis is a predisposing cause of cancer. Even

if an individual has a positive Wassermann reaction and a gastric lesion, that does not prove he doesn't have cancer.

One reason for presenting this paper was that there is a common lack of knowledge on the part of surgeons and internists of what I have presented in this paper. Many surgeons are not aware of the fact that benign ulcer of the greater curvature scarcely ever occurs. I read this paper in brief at a meeting of the New England Roentgen Ray Society last winter and later was informed of a case that illustrates this lack of knowledge very well. In a neighboring hospital, a roentgenologist who had heard this paper had a patient with a lesion on the greater curvature which was only half the size of one I have just reported. The roentgenologist insisted because of its location that it was cancer. The surgeon insisted, and the internist insisted it was ulcer and should be treated medically. However, the roentgenologist finally won the point and the patient was submitted to laparotomy. At laparotomy a carcinoma one centimeter in diameter and situated exactly in the greater curvature was found. From that cancer one centimeter in diameter, there was such extensive metastasis to the lymphatic glands it was thought unwise to attempt to do any resection of the stomach.

With regard to the final outcome of my case, on August 25 of this year, I sent for this young lady to come back for reëxamination before I came here so I might report on her condition. She is still in good flesh and having some slight distress, not nearly so good as she was right after her operation. As you will see from this slide (Fig. 9) there is now a recurrence at the site of the resection. She now has an annular carcinoma of the stomach. Early in September she submitted to laparotomy. An annular carcinoma was found at the site of the resection and metastasis to the lymphatic glands was very extensive. Nothing was done except a lymphatic gland was removed and that showed metastatic carcinoma. This matter of the occurrence of ulcer on the greater curvature is of some importance, because the surgeon presumed in the first place he was dealing with an ulcer. He did an ulcer operation. The question arises, might he have saved the girl's life by being aware that there is probably no such thing as benign ulcer of the greater curvature and had therefore have operated for carcinoma. instead of ulcer?

EXTRA-BOWEL PATHOLOGY*

By P. F. BUTLER, M.D., *Radiologist, and* MAX RITVO, M.D., *Visiting Roentgenologist*
Boston City Hospital
BOSTON, MASSACHUSETTS

A BRIEF review of the development of the large bowel will help to simplify an understanding of conditions affecting it. The early fetal mesentery extends outward from the posterior abdominal wall, connecting up with the entire large bowel which hangs loosely from the posterior wall. During development, however, certain portions of the large bowel (cecum, ascending colon, descending colon and rectum) become fixed to the posterior wall and their mesentery disappears. The transverse colon and sigmoid retain their mesentery through life and permit of free mobility. The hepatic flexure is fixed at the level of the first lumbar vertebra and the splenic flexure is fixed opposite the twelfth dorsal vertebra. In about one-fourth of all cases there remains a small sheet of mesentery in both the ascending and descending colon; this results in some mobility on both sides, that on the right being known as the mobile cecum. Having in mind the fixed, or retroperitoneal, portions of the large bowel and the movable portions, we can more easily understand displacements and deformities by tumors and inflammatory processes outside the bowel.

Tumors of the abdomen and pelvis are relatively common and the diagnosis of the location, nature, and size of the mass is frequently a matter of great importance. This is often difficult or entirely impossible by ordinary clinical methods. Pneumoperitoneum and similar methods of study in this type of case have not been found applicable for routine use because of the dangers and difficulties associated with these procedures. In tumors of the gastrointestinal tract, roentgen examination after the administration of a barium meal usually enables one to arrive at a diagnosis. Tumors outside of the gastrointestinal tract are not studied routinely in this way by many clinicians. However, we have found in a large series of cases that studies of the displacements of the stomach and intestines by masses in the pelvis and abdomen give very valuable information about the tumor. The procedure is simple, painless, and easily carried out.

The technique of the examination in cases in which an extra-alimentary mass is suspected is as follows: Plain films of the abdomen in the anteroposterior, posteroanterior, and lateral projections are taken to visualize the mass if possible. The tumor is seldom dense enough to show on these films, though in the rare case in which it is demonstrable, the examination proves to be of great value. A barium meal is then given and roentgen films and roentgenoscopic study made of the stomach as usual. The patient returns for three hour, six hour, twelve hour, and twenty-four hour observations. The three hour observation is valuable in that it shows the small bowel. Occasionally, it may be necessary to see the patient at two hours and four hours after the ingestion of the opaque meal to study the small bowel. In the case of tumors which displace the colon, forty-eight hour films or barium enema studies are made if necessary. Roentgenoscopy combined with palpation is extremely important to determine the mobility of the mass, the presence of adhesions to adjacent organs, to rule out inflammatory changes, tenderness, etc. The patient should be observed in the prone, supine, lateral, and oblique positions; frequently studies in the erect position give very important data not obtainable otherwise. For purposes of simplification the abdomen is divided into four parts in this description:

1. Left upper quadrant.
2. Right upper quadrant.
3. Epigastrium and hypochondrium.
4. Pelvis and lower abdomen.

* Read at the Thirty-first Annual Meeting, American Roentgen Ray Society, West Baden, Ind., Sept. 23–26, 1930.

TUMORS OF THE LEFT UPPER QUADRANT

In the left upper quadrant, there may occur tumors and enlargements of the spleen, left kidney, splenic flexure, stomach, left lobe of the liver, and tail of the pancreas. Enlargements of the spleen cause very typical pressure deformities of the gastrointestinal tract and can usually be diagnosed without difficulty. Slight enlargement gives a smooth indentation of the greater curvature side of the stomach in the region of the cardia and media; associated with this, there is a flattening and downward displacement of the splenic flexure (Fig. 1). As the enlargement becomes greater, the stomach is displaced more and more; it may be pushed downward to the right and compressed. The splenic flexure is forced downward to the right also. With very marked enlargement, the upper and middle portions of the stomach are very markedly narrowed, the left side of the colon is pushed down and to the right and the small bowel is also displaced similarly. The extent of the enlargement can be demonstrated by these studies, and it is often possible to determine if the borders of the mass are smooth or irregular in outline.

FIG. 1. Deformity of gastric outline due to enlarged spleen.

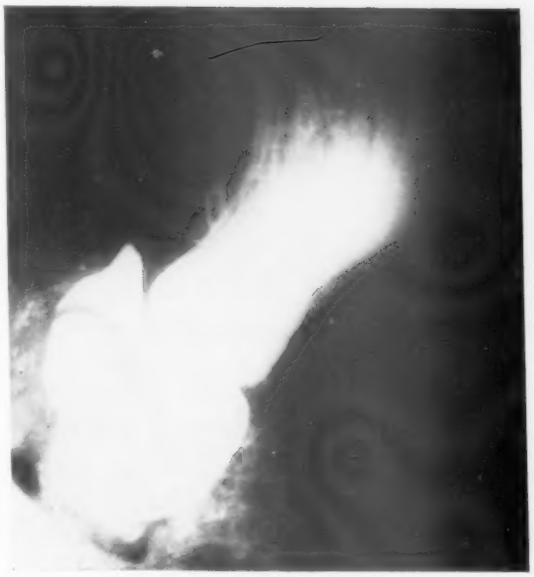

FIG. 2. Smooth pressure deformity of the greater curvature due to hypernephroma.

Tumors of the left kidney must be quite large in order to cause deformity of the stomach or bowels, and in this respect differ from the spleen. The enlargement in this instance is posterior rather than lateral to the gastrointestinal tract, so that the deformity is in the nature of a compression from behind. As the mass becomes larger, the stomach is displaced toward the midline, the effect being particularly on the media and pyloric end (Fig. 2). The transverse colon is displaced downward. The splenic flexure may be pushed to the left and compressed against the lateral abdominal wall or, more rarely, displaced downward and to the left.

Tumors of the splenic flexure and adjacent portions of the colon may cause pressure deformities of the stomach, the defect varying with the size and location of the mass. If the neoplasm is malignant there may be direct invasion of the stomach wall. Studies of the colon by barium enema make the diagnosis clear. Tumors of the stomach may, similarly, cause pressure defects of

Fig. 3. Tumor of the lesser peritoneal cavity deforming the gastric outline.

the adjacent portions of the colon or small bowel, the type of displacement depending on the location and size of the mass in the stomach. This usually gives no difficulty in diagnosis as the roentgen studies of the stomach show the cause of the deformity. The left lobe of the liver may displace the stomach and splenic flexure downward and to the left according to the degree and type of enlargement of the liver. This condition is rare and not of great importance.

Tumors of the tail and body of the pancreas usually cause deformities of the greater curvature side and lower portion of the stomach. The defect usually is rounded, smooth in outline, and changes as the position of the patient is changed. The distal third of the transverse colon may be displaced downward and to the left. In some instances, the mass may grow into the lesser peritoneal cavity causing a flattening of the lesser curvature side of the stomach and marked narrowing of the lumen of the media and antrum (Fig. 3). These deformities also vary with the position of the patient, being most marked with the left side elevated and usually disappearing with the right side elevated. The upper loops of the jejunum are displaced downward and to either side by tumors of the tail and body of the pancreas. The splenic flexure is displaced to the left; the transverse colon is usually pushed downward, though rarely it may be displaced upward. Tumors of the head of the pancreas and adjacent portion of the body cause a different type of displacement and are discussed under masses occurring in the epigastrium and hypochondrium.

RIGHT UPPER QUADRANT TUMORS

Enlargements of the liver, if slight, may give no tyical displacement of the stomach or intestines. With moderate or marked increase in the size of the liver, the hepatic flexure is displaced downward and toward the midline. The upper jejunal loops show similar changes. The stomach is pushed downward and to the left; it may be narrowed also. These changes are usually constant in all positions, but are most marked with the patient lying on the left side or standing erect. In ptosis of the liver, simi-

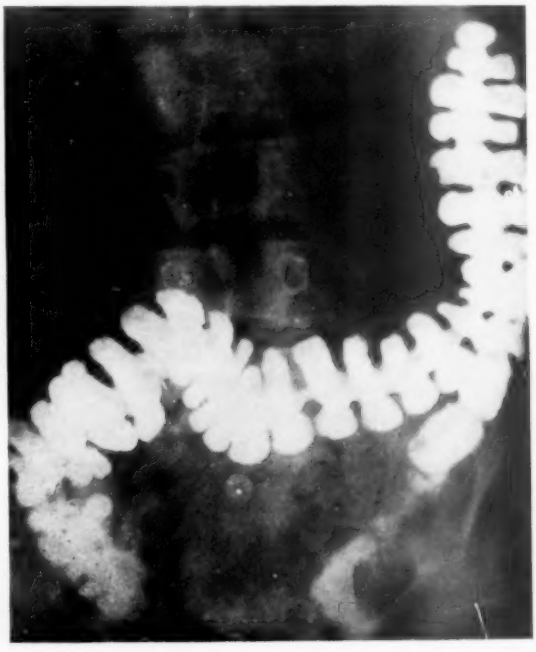

Fig. 4. Enlarged liver displacing hepatic flexure of the colon downward.

lar changes may be present, so that differential diagnosis becomes very difficult. It may in rare instances be possible to demonstrate irregularities of the lower border of the liver. With slight enlargements of the liver, the hepatic flexure is displaced before any defect of the stomach is demonstrable (Fig. 4).

Tumors and enlargements of the right kidney must be pronounced to cause deformities of the gastrointestinal tract. Usually the transverse colon is displaced downward. The hepatic flexure may be pushed downward and to the right. As the lower pole of the kidney is round and somewhat blunted, the defect is usually sharply defined and smooth in outline. In the lateral projection, it may be possible to prove that the pressure is from behind, the colon being pushed anteriorly.

Enlargements of the gall-bladder may cause a downward displacement of the proximal portion of the transverse colon. This displacement is localized, usually affects the proximal third of the transverse colon, and causes a concavity of the portion of the bowel involved, therefore differing from the condition seen in liver enlargements. The duodenum and pyloric end of the stomach are also flattened and deformed by enlargements of the gall-bladder (Fig. 5). If the gall-bladder can be visualized with the dye, the cause of the deformity can in this way be proved definitely.

Fig. 5. Carcinoma of the gall-bladder deforming the pyloric end of the stomach and duodenum.

Fig. 6. Carcinoma of the head of the pancreas displacing the third portion of the duodenum downward and causing a smooth pressure deformity of the greater side of the pylorus.

Tumors of the hepatic flexure may in rare instances cause displacement of the adjacent portions of the intestines. These lesions, however, are demonstrable by the barium meal and opaque enema studies and the diagnosis thus made clear.

TUMORS OF THE EPIGASTRIUM AND HYPOCHONDRIUM

Enlargements of the head of the pancreas cause a displacement of the duodenum which is usually so characteristic as to be definitely diagnostic. The first portion of the duodenum is displaced upward; the pylorus and antrum may be displaced similarly. The second portion of the duodenum is displaced markedly to the right and frequently is flattened and narrowed. The third and fourth portions of the duodenum are displaced downward. As the mass en-

Fig. 7. Carcinoma of the head of the pancreas deforming the pyloric end of the stomach.

larges, the displacement increases in all directions. The upper loops of the jejunum are displaced downward and laterally (Fig. 6). As tumors of the head of the pancreas are difficult of diagnosis by ordinary clinical methods, the roentgen examination is of greatest importance in this type of case. The displacement is usually symmetrical, so that the entire duodenum makes a wide, sweeping curve downward and to the right. Sometimes, however, the pancreatic tumor is irregular in outline and then the pressure deformity of the stomach is irregular. This sign is pathognomonic of carcinoma while the rounded enlargement of the pancreas may be cyst or carcinoma (Fig. 7). In gallbladder adhesions about the duodenum, the curve of the duodenum may also be increased, but it is usually irregular and angulated and there is distention of the loops involved with delay in the passage of the opaque meal through the duodenum.

Cysts of the mesentery and retroperitoneal tumors are infrequent. If they attain sufficient size, they cause definite displacement of the stomach and intestines, depending on the location and contour of the mass. A very typical roentgen finding in these cases is the absence of loops of small bowel in regions where they should normally be present, and no displacement of the retroperitoneal portions of the duodenum (Fig. 8). It is necessary therefore to examine the patient at intervals of one or two hours after the ingestion of the barium meal in order to visualize every portion of the small intestines. The stomach and colon may also be displaced if the tumor encroaches on the locations of these organs.

Tumors of the transverse colon may displace the lower pole of the stomach and small intestines (Fig. 9). Here, as in all tumors of the gastrointestinal tract, the barium meal and opaque enema studies make the diagnosis clear. Primary malignancy of the peritoneum is very rare. Tumors of the peritoneal cavity are usually malignant; most of them are secondary to a focus elsewhere.

Fig. 8. Cyst of small bowel mesentery elevating and deforming the stomach outline.

MASSES IN THE PELVIS AND LOWER ABDOMEN

Tumor masses in the pelvis and lower quadrants of the abdomen usually cause characteristic displacements of the intestines. In many instances, much valuable information as to size, shape, and origin of the tumor may be gained by the barium meal examination of the gastrointestinal tract (Fig. 10). These studies are so easily made that they should be used routinely before resorting to cystography, uterosalpingography, and similar procedures. In many instances, the evidence obtained from the barium meal examinations may make these methods of study unnecessary.

Enlargements of the uterus give an upward and lateral displacement of the small bowel. The lower border of the intestinal shadow is rounded and convex. In pregnancy, this enlargement may be demonstrated as early as the third month, making the diagnosis possible several weeks prior to the time when the fetal skeleton outline becomes visible. By repeated examinations at intervals of a few weeks, the typical symmetrical increase in the size of the uterus during parturition may be clearly shown (Fig. 11).

Fig. 9. Carcinoma of the transverse colon displacing the pyloric end of the stomach and the jejunal loops.

Fig. 10. Diffuse carcinoma of the pelvis which has elevated the small intestines from their usual position.

Cysts, fibroids, and other pelvic tumors may, if sufficiently large, also be shown by the displacement of the intestines which the mass causes. These tumors usually are asymmetrical and not in the midline, so that the displacement of the ileum is more to one side and therefore differs from that seen in pregnancy. The full bladder may displace the small intestines upward also; however, re-examination after the emptying of the bladder shows the intestines returned to their normal position low in the pelvis. In abscess of the appendix, there is a very typical displacement of the terminal ileum, the loops of the intestines encircling and walling off the abscess (Fig. 12). In pelvic abscesses the picture is similar, except that the mass is lower. Roentgenoscopic studies are essential in cases of suspected appendicial or pelvic abscess in order to demonstrate adhesions of the loops of intestines and to determine the pres-

Fig. 11. Pregnant uterus which has elevated the small intestines and displaced them laterally.

ence of localized tenderness over the inflammatory mass.

The displacements of the intestines by pelvic and lower abdominal tumors have been discussed in more detail in previous papers, and are reviewed here for the sake of completeness.

SUMMARY

1. An attempt is made to present methods of study in the presence of tumors outside of the gastrointestinal tract.

2. Displacements and deformities of the gastrointestinal tract are interpreted in relation to extra-bowel pathology.

3. Considerable information can be obtained by this simple procedure.

4. Many of these signs are found in routine gastrointestinal examinations and overlooked; we wish to emphasize their significance.

DISCUSSION

Dr. Fred W. Rankin, Rochester, Minn. I should like very much to discuss this paper intelligently, that is, from the standpoint of a roentgenologist, but I am totally unable to do that, naturally. However, I was very happy to have an opportunity to hear this very excellent paper, and I am sure that all of you agree with me that by the signs and methods outlined, a great deal of advantageous data may be gathered in the diagnosis of extrinsic lesions of the bowel. I think Dr. Butler and Dr. Ritvo are particularly fortunate in their demonstration of the tumors of the pancreas. The epigastric tumors, which are pancreatic in origin, are very difficult of diagnosis most frequently. It is not only by ruling out intrinsic lesions of the upper and lower gastrointestinal tract, but by the demonstration of these signs they have called attention to that accurate localization of that tumor, which may be hard or may be cystic, may point to the epigastrium or below the stomach, is made.

I can't resist this opportunity to say something about the intrinsic lesions of the large bowel, for I have been particularly interested in them. I very gratefully acknowledge the debt that the surgeon owes to the roentgenologist in the diagnosis of these lesions, particularly cancer. I don't think there has been any advance in the diagnosis of cancer of the large bowel which, of course, in turn is reflected in the type of treatment, the stage at which treatment is undertaken and the type of operation which may be accomplished, as the im-

Fig. 12. Appendicial abscess with subsequent deformation of the cecum and displacement of the terminal ileal loop.

provement in roentgenological technique which has taken place in the last five or ten years.

I think that formerly we looked upon an accurate localization of an intrinsic lesion of the stomach or duodenum as a fairly routine, easy, simple matter. The diagnosis of duodenal ulcer is relatively satisfactory and sure, or gastric ulcer for that matter. Yet it is only recently that the diagnosis of carcinoma, for instance, of the large bowel has approached in anything like a satisfactory degree to the accuracy of the diagnosis in the other upper parts of the gastrointestinal tract. With the proper preparation and cooperation of the patient, I think that statement of an accurate diagnosis in cancer of the large bowel, beyond the reach of the proctoscope (and that, by the way, is the only type of lesion which should be x-rayed) is correct. I am sure you will all agree with me that roentgenography for lesions of the upper rectum and rectosigmoid is contraindicated where proctoscopy can make a more satisfactory, a quicker, easier, simpler diagnosis; but beyond the middle third of the sigmoid, it is no longer a unique experience, but it is an actual fact that carcinomas and other organic lesions of the large bowel may be diagnosed with the same accuracy with which lesions of the upper intestinal tract are diagnosed. That is a most important fact, and I think we can utilize it a great deal more frequently than it is being utilized now, because as periodic examinations are becoming more and more the vogue, I think the time is not far distant when a routine roentgen examination of the colon will be considered just as necessary and will give just as accurate data in a complete physical examination as a routine examination of the chest or the upper gastrointestinal tract.

Dr. William H. Stewart, New York City. We are appreciative of Dr. Butler's paper and agree that every effort should be made to make a diagnosis with a method giving the least disturbance to the patient.

In all cases of obscure abdominal lesions we carry out the examination exactly as Dr. Butler has recommended, but we do not believe that in many of these cases which he has shown and others that we have had during our experience, it is so easy to tell the character of the pathology. Pressure deformities can be caused by so many different lesions that we gave up long ago trying to tell "what they are" by simple means. This very question was the cause for pneumoperitoneum; it is, in our hands at least, a safe procedure and irrespective of the knocks it has received from some of our friends in the field of roentgenology, it is not by any means dead. We have been using the method in the institutions with which we are connected for years and have never had a fatality. Since using the rapidly absorbed carbon dioxide our results have been particularly gratifying.

The following two cases will illustrate the value of pneumoperitoneum. Both were young girls with a large abdominal mass which gave signs of fluid by palpation, thought to be free in the abdominal cavity. Competent surgeons and internists who examined both of them were unable to decide the character of the lesion. In the first case (slide) we used a generous-sized trocar and drew off a portion of the fluid which was replaced by carbon dioxide, and the roentgen examination showed a cyst wall containing gas and fluid. At operation the cyst proved to be ovarian in origin.

The second case (slide) was of the same character. The diagnosis could not be made before pneumoperitoneum was used; afterwards it was easy to outline the cyst wall containing gas and fluid. This was confirmed surgically. Pneumoperitoneum is here to stay and in many instances it safely replaces exploratory laparotomy.

Dr. Butler (closing). I agree with Dr. Stewart that pneumoperitoneum has its place and we still make use of it. The fact remains, however, that pneumoperitoneum is not as commonly in use as this ordinary routine. My only object in presenting this subject is to bring to the attention of the members these various signs which are frequently overlooked in routine examination of the gastrointestinal tract.

TREATMENT BY RADIUM*

By HARRY H. BOWING, M.D.
Section on Therapeutic Radiology, The Mayo Clinic
ROCHESTER, MINNESOTA

RADIUM AS A CONSTANT SOURCE OF ENERGY

RADIUM as a constant source of a bundle of rays or particles suitable for therapeutic purposes has been employed for more than thirty years. Progress in its use, in the main, has been steady and straight-forward, and therefore the agent has been recognized as of merit by physicians competent to judge. However, its right to claim a place in medicine has been doubted by certain observers.

It is well for all concerned and especially for those who understand the problem before us, to emphasize, whenever possible, the important truth that the science of radium treatment is founded on a rational basis. The constant flow of energy, as well as the accuracy of the measurement of the quantity and quality of this beam of energy is ideal. With a complete record of the factors of treatment used, a given technique can be repeated at will. Therapeutic range seems unlimited since the scale of intensity can be varied from a very weak source, for example, a gold or platinum seed for interstitial treatment, to the present-day use of a pack of 4 gm. or more. The time of application can also be varied within fairly wide limits. These desirable factors assure great flexibility and account partially for the value of radium as a therapeutic agent. It is highly important that the radiotherapist should fully appreciate the value of this wide range of intensity and distribution of energy in outlining the technique to be employed in any given case. It is gratifying to know that there are individuals and institutions working intensively to determine the best technique for a certain pathologic condition and it may be confidently assumed that definite data will be forthcoming further to enhance the present status of the agent in medicine.

The absorption of this therapeutic energy in the field of treatment constitutes the dose. The absorption coefficient of tissues and filters has been satisfactorily estimated. When distance is used, the inverse square law governs in a measure the intensity in the treatment field.

The foregoing statements point out briefly the accuracy possible in a given technique and the desirability of the element radium as a constant source of energy in effecting this novel treatment. It may come to pass in the near future that the initial cost of the element will be greatly reduced, thus permitting wider distribution of the agent in sufficient quantities in treatment centers, where the maximal good may be obtained by the patient, and where men and women may be efficiently trained in the art of radiotherapy. It is not my purpose to minimize in any way the satisfactory work and good results already obtained by the conscientious worker whose supply of radium is limited, for his efforts have done much to keep the treatment alive, and valuable contributions may be expected to accumulate from this source of endeavor.

THE VARIABILITIES OF TREATMENT BY RADIUM

Physical measurements as furnished by the laboratory are very important to the science of therapeutic radiology. The data are exact, definite and reliable, and we must fully appreciate their value, and yet to transpose this information into terms of biophysical measurements or effects on tissue is practically impossible. As yet we do not know how the absorbed energy in the field of treatment produces or causes the therapeutic result.

The radiosensitivity or radioresistance of different kinds of normal and pathologic

* Presidential address before the American Radium Society, Detroit, Michigan, June 23–24, 1930.

tissues has been, for therapeutic purposes at least, well established. The rate of growth of neoplastic tissue is fairly well known. In the aggregate, these entities are definite; however, in a given case they occur in varying degrees, thus making the interpretation of their value in treatment a difficult one.

The grading of malignancy is decidedly important. It should guide us in outlining the initial as well as the subsequent treatment or follow-up regimen. It is fully appreciated that malignancy graded 3 and 4 responds readily to treatment and yet on account of the tendency in such cases to extend and metastasize widely even though healing of the primary lesion was satisfactory, the ultimate prognosis must be a guarded one. Malignancy graded 1 or 2 responds to treatment, and the experience of the radiologist in such cases is similar to that of the surgeon in that the primary lesions heal or are controlled, and the ultimate prognosis is decidedly more hopeful.

The foregoing information regarding neoplastic disease may be known in the abstract and yet with the same technique the results may vary in individual cases; in other words, all patients do not respond alike to the same technique. However, it is essential to attempt to evaluate these individual differences during the periods of observation and treatment. The therapeutic response observed following the initial applications of radium is of value in estimating the probable total biologic effect, assuming of course that the broken-dose intensive method of treatment is employed. The treatment of carcinoma of the cervix uteri is a good example, for during a complete course of treatment it is possible to estimate the response from the treatment applied as well as to estimate the amount or total dose to be applied in a given case. The broken-dose method, when feasible, contains many valuable features to recommend it, for it furnishes a method or lead in estimating the treatment value of many variables.

COÖPERATION AND COÖRDINATION

It can be established beyond doubt that a given technique can be repeated within the range of therapeutic accuracy at will; however, the local or general response exhibited by the patient cannot as yet be so definitely estimated. Failure of the primary lesion to heal is usually the result of inadequate technique, rather than the failure of the element radium as an unsatisfactory therapeutic substance. It is grossly evident that individuals should respond to treatment in an individual manner. Much of the art of radium treatment is dependent on the physician's experience or radiotherapeutic judgment. Today the wide-awake therapeutic radiologist welcomes information and assistance from the attending physician and laboratory workers. He is certain that only through willing coöperation of all concerned can the best interests of the patient be fostered and the science of treatment by radium be advanced.

It is important to know the general condition of patients since if their health is good, they tolerate treatment well and should complications arise, such as secondary infection, hemorrhage, and systemic effects from treatment, their return to apparent good health is more prompt and certain, and if their health is undermined, cautious treatment only is indicated. This surely emphasizes the all-important fact that thorough general examination of the patient should precede treatment. An undiagnosed condition should not receive treatment. However, there are cases in which a therapeutic test may be applied. During the period of treatment the patient should be watched carefully, since serious complications may arise and, as time passes, the patient should be watched diligently and repeated examinations should be made at stated intervals. Patients may respond satisfactorily to local treatment, and within a short time activity may occur in the primary field. If this process is recognized early and treated adequately, the period of palliation will surely be lengthened. As a rule, the patient's judgment re-

garding his future care is not sufficient to guide him; therefore the physician must assume the responsibility and assign a definite time for the check-up examination. This purposeful program should not be relinquished no matter how tedious it may be for both patient and physician.

THERAPEUTIC RATIONALE

As yet the true etiology of malignant disease has not been determined; nevertheless it seems expedient that an idea should be formulated regarding the cause of neoplastic disease in order to plan and execute a rational therapeutic attack. It seems far better to have even a tentative idea even if it proves later to be wrong. It is equally true that a method of treatment should be formulated rather than to begin hit-or-miss treatment without it.

It seems probable and well within good judgment to assume that malignant neoplastic disease most frequently begins as a local or regional process, and eventually spreads by direct extension, or by the way of the lymphatics and blood vessels, to distant parts. In a few cases spread may occur through contact and implantation. In some instances, malignant ovarian cells particularly seem to have the ability to migrate.

Aside from local manifestation of the disease it seems reasonable to assume that there are deviations from the normal, and in all likelihood this feature of the disease explains why malignant disease does not always develop, even though the same irritants, exciting or carcinogenic factors, were present. Another possibility is the presence of a defense mechanism, or a natural curative power varying in degrees of intensity, to assist the patient to overcome the disease. This mechanism may be reflected in the pathologic and clinical aspects of the disease. It may account for the different pathologic pictures observed, even though the tissue is that of an ordinary squamous-cell epithelioma. The primary cells may appear alike; however, the structure produced, as well as the quality and quantity of the supporting stroma, may vary greatly. Further, this mechanism may be responsible for the good results obtained, particularly in case of apparently inadequate treatment. I have observed cases in which only limited treatment was given because of the development of serious complications, and yet recovery was complete and satisfactory. I am certain many workers in this field have observed cases following treatment that would support this statement. The other method of approach may be likened to the surgical procedure, which is to remove the neoplastic process either by a recognized surgical procedure or by some type of cautery removal; so too with the radiotherapist the inherited idea is to remove the lesion by destructive irradiation methods. When the method of approach is destruction of the lesion the ability of the patient to assist in combating his disease does not enter into the plan. It seems possible to treat certain types of neoplasms by radium so that the natural mechanism may be brought into play. In such cases a nondestructive or therapeutic dose is given, a dose which is apparently sufficient to hasten a tendency of the neoplasm to approach normal tissue growth. It is obvious that destructive methods must not be employed in such an approach, for necrosis would occur, and the débris would be removed through phagocytosis and resulting reparative processes. With employment of the nondestructive or therapeutic dose, as a rule the new growth disappears and apparently the affected part is completely restored to normal. For example, in the presence of carcinomelcosis the malignant and inflammatory elements subside without being intensified. The field of treatment is gradually cleared of the gross malignant and ulcerating process. The changes in tissue brought about by such reparative or restorative mechanism is worthy of much study, and such study may lead to a better understanding of malignant disease. An opportunity is available for the observation, in a measure, of the effects of varying degrees of a carcinolytic process as produced by intensive de-

structive doses or by a nondestructive dose. My observations are fragmentary; however, the effects on tissue produced by the nondestructive dose should be given further investigation and interpretation. Definite recommendations with regard to treatment cannot be made at this time. It should be borne in mind, however, that there are two methods of approach: removal or destruction of the growth, and hastening the growth tendency to assume a normal tissue rate. In using radium, local treatment should be thorough and metastasis to distant fields must be appreciated. Emphasis should also be placed on the natural mechanism and the fact that care must be taken not to undermine the patient's general health by the treatment; every possible measure should be employed to assist the patient to overcome the malignant invasion.

THE DIAGNOSIS OF NEOPLASTIC DISEASE

There is no reliable serologic test to confirm clinical data regarding neoplastic disease. However, this is not serious in making an accurate diagnosis, since in the average case of carcinoma involving the superficial tissues of the body or the tissues of the superficial cavities, the diagnosis can usually be made from the history and by careful palpation and inspection of the part. There are few benign lesions thus situated which simulate carcinoma. Carcinomas involving the deeper structures of the body are not easily diagnosed, and in some cases exploratory operations are necessary in order to confirm the clinical data as well as to indicate the method of treatment. In some cases biopsy or removal of an enlarged lymph node may be necessary for microscopic study before the diagnosis is made. Today the clinician and surgeon appreciate the dangers attached to the procedure of surgical biopsy and this is done only when absolutely essential. On the other hand, the removal of a very small piece of tissue from the denuded surface of the malignant lesion for microscopic study is attended with very little, if any, risk, but even this is not employed as a routine procedure. It is not necessary to cut deep into the area, which might involve cutting through the defense region. It should be noted also that biopsy is usually obtained for the purpose of advancing our knowledge of malignant disease instead of making further studies to establish the diagnosis. In the average case the patient presents the typical textbook picture of the disease, a sad commentary on this age of enlightenment. This is particularly regrettable since the primary lesion is frequently readily accessible to adequate measures to control it in its early phases. And yet much valuable information has accumulated in the treatment of these apparently hopeless cases, and treatment by radium has advanced. In nearly all cases a degree of palliation is now possible and under certain conditions the patient may recover for periods of five years and longer.

The pathologist should appreciate the importance of grading neoplasms sent to him for special study. The work of Broders and others in this field has been a distinct step in advancing knowledge of this dreaded disease. In a measure it assists in planning the primary treatment, and helps to formulate a follow-up plan in the future care of the patient. The surgeon now appreciates his limitations in operating on highly malignant neoplasms, for example, those graded 3 or 4, while the radiotherapist appreciates the rapid response these types exhibit to treatment.

To estimate the factors that determine radiosensitivity or radioresistance is far from being a simple procedure. Ewing stated: "The radiosensitivity of epidermoid carcinomas is referable to many factors, including anaplasia, vascularity, desmoplastic reaction, rate of growth, and especially the tissue of origin." The grading of tumors for the most part takes into account these factors.

PROPER CLASSIFICATION OF CASES

The early diagnosis is important for it is in the early lesions that the highest per-

centage of initial and lasting good occurs. All efforts should be concentrated on this truth. The task involved is great. In brief, education will do much to bring the early cases to the physician qualified to employ adequate measures. The profession and laymen must be instructed or reminded regarding the recognition of the early signs of neoplastic disease and the importance of instituting immediate and effective measures to overcome it. Too much should not be expected from the radiotherapist alone since his patients are usually referred to him. His task, however, should be to encourage and assist the physician who has the difficult problem of advising patients when they present themselves for examination.

The physician who has the opportunity to examine patients as a routine must be on guard constantly to observe slight changes in tissue which may indicate a malignant process. The same is true of apparent slight changes or alterations of function of tissue as observed by the patient. These should awaken the keen observer to the possibility that such complaints or signs may indicate malignant change. Such care in examination must be exercised by the radiotherapist, in order to obtain good primary results or to maintain good initial results from treatment, and it should be grossly obvious to all that the same care should be exercised by physicians who examine the patient for the first time. The early recognition and diagnosis and the immediate institution of adequate measures of treatment will greatly enhance immediate and late results.

Patients who are treated in the early stages of the disease should be carefully observed in a group by themselves, instead of in the large group with inoperable lesions. Here success or failure should be carefully analyzed. It is true that some knowledge is gained from treatment in the inoperable case. However, all rules do not apply and especially when the important factor of individualization is considered. Early cases are too few for generalization. This consideration emphasizes the importance of carefully classifying cases.

A definite classification or grouping of cases that would be acceptable to all observers cannot be formulated, but if those who are making reports will add the necessary data or explanation of their classification it will be possible for other observers to transpose figures and results and obtain the comparative truth from such study. Probably the best basis for such classification is anatomic rather than surgical or radiologic as viewed by the physician. The site of the primary lesion and the extent of invasion of local or distant tissue should from a radiotherapeutic standpoint furnish a satisfactory basis for classification. Results are now governed in the main by the site of the primary lesion and the extent of local and general involvement or invasion of the disease. In cases of early operable or small primary lesions results are comparatively good if adequate individual measures are employed; further, it is the rule that the inoperable or advanced lesion and recurring lesions will respond. The degree and length of the response cannot be measured accurately when the first course of treatment is applied. Certain lesions are decidedly sensitive to the absorbed therapeutic rays, and the initial results as well as the late results are startling. This possibility should awaken a keen interest in all cases except those in which the disease process has so undermined the health of the patient that his life expectancy can be estimated in terms of weeks. It requires at least two to four weeks for the initial response to manifest itself.

The operable or borderline lesion should receive all that is possible from the field of surgery and therapeutic radiology. It is encouraging that malignant cells can be favorably altered through irradiation and the valuable data now available should be employed in the treatment of this group. Definite recommendations are not possible, but both the surgeon and the radiologist must know their limitations in outlining the measures to be employed. From the stand-

point of treatment by radium, our considerations should center about the good to come from preoperative, postoperative or nonoperative treatment and the follow-up program. Again the limitations imposed will not permit more careful or detailed consideration.

It is of fundamental importance that an adequate dose be absorbed in the treatment field. In the event of preoperative treatment of the early or borderline lesions, the time interval should be sufficiently long, probably six to eight weeks, to permit the maximal healing or response of the tissues to have occurred before surgical intervention is carried out. Another method of preoperative treatment is to give a decidedly destructive dose, and before radionecrosis occurs wide excision of the treated area. The latter procedure carries a greater risk, whereas the former permits the local lesion to heal and the general condition of the patient to improve, thus reducing the surgical risk. The preoperative preparation of these patients in selected cases should produce better results than any other one measure alone.

In the event of irradiation alone the treatment must be fully sufficient since in the case of inadequate, improper treatment and time interval there are usually the cells that have received (1) overirradiation, leading to radionecrosis; (2) sufficient irradiation but too limited for good results; (3) inadequate irradiation which will probably be thrown off by the cell, and (4) no irradiation which makes possible local extension and spread of the disease during the period of recovery.

In the event of only postoperative or prophylactic treatment the applications of radium are usually limited. However, they are indicated and the result should be better than when operation alone is used.

In certain situations, even though the lesion is inoperable, the surgeon can be of assistance to the radiotherapist in that he can convert a deep lesion into a surface lesion. As a rule, the added risk of the surgical approach or exposure is not great and may be disregarded when the possible good result to be obtained from the combined method is considered.

CLASSIFICATION OF CASES ACCORDING TO TREATMENT

To outline and apply adequate irradiation is another important factor, and cases should be classified accordingly. It is a serious mistake to consider all cases under one heading in which radium treatment is used. Such error is usually made by those who conclude that from any type of treatment the response should be equal. Instead, the variety of results obtained may be attributed to the different methods of treatment. It is important to know all that has been done before judgment is passed as to the efficacy of radium as a therapeutic procedure. My procedures in treatment are as follows:

At the time the patient is first seen treatment is outlined, based on the radiotherapeutic judgment of the consultants, and if this program is carried through the case is classified as one in which a complete course of treatment is given. In some cases, especially the inoperable cases in which the patient's health is markedly undermined, this is impractical; however, a limited amount of treatment can be applied with benefit. In the latter event, the treatment is classified as limited. In other cases it may be that the site of the disease may make it impossible to apply a complete course of treatment. When it is necessary to stop treatment in either of the foregoing programs, the case is grouped as one in which the treatment was abandoned. Prophylactic treatment is given to patients who have had adequate surgical treatment. The procedure is supporting, and a rather set or routine technique is employed. It would seem necessary, therefore, for proper interpretation of the value of radium as a therapeutic substance and the choice of conditions amenable to irradiation, that patients be further grouped for study according to the amount of treatment, and the technique employed.

SUMMARY AND CONCLUSIONS

1. Treatment by radium of malignant and many nonmalignant conditions is valuable and dependable.

2. The large group of patients so far treated is made up of those with inoperable or apparently incurable lesions, and yet much suffering has been relieved and many patients have been saved for periods of five and ten years and longer. Since this is possible it seems reasonable to conclude that the patient with an early or operable lesion, if it is adequately treated, should receive much more benefit and probably be cured of this destructive disease.

3. Patients are presenting themselves for consideration at a time when the disease has advanced beyond the primary site, and palliation is all that can be expected. The early recognition of a neoplasm on the surface of the body or in the semisuperficial cavities of the body should be a simple matter. If this phase of the problem were generally understood, end-results of treatment would be much superior to those now being reported, and the morbidity and mortality rate would be greatly reduced.

4. Our most efficient method of treatment at present is some type of operation, and radium and roentgen radiation used either singly or in combination. A combination of procedures brought about by coöperation and coördination of effort should give the most lasting result.

5. The recognition and treatment of deep-seated malignant disease furnishes a more serious or complex phase of management. However, an earnest effort to interpret slight subjective and objective complaints or signs should bring about earlier recognition and treatment.

6. In general, radium when used alone has a wide field of usefulness. However, when combined with surgical procedures, its field is definitely enlarged and extended. Further, during or following treatment, surgical intervention may be necessary. The surgical staff, as a rule, appreciates the limitations of methods in dealing with certain types of lesions and welcomes the aid furnished by the radiologist. In like manner, the radiologist welcomes the aid given in facilitating adequate approach to the lesion to be treated, and the more the radiologist fashions methods after a thorough surgical technique, the more efficient he will become in applying radium. In short, his task seems a double one. He must know the significance of the physics or the laws that govern the energy he is applying, and he must appreciate the newer interpretations of clinicians, surgeons, and pathologists.

7. It is a step in the right direction to attempt to grade neoplastic disease, since it may lead to a better understanding of the characteristics of radiosensitivity and radioresistance. The grading of malignant growth helps also to outline the preoperative, postoperative and nonoperative radiotherapeutic management of the cases under consideration. Lesions graded 3 or 4 early spread to adjacent and distant parts; therefore, treatment alone or after operation must be exacting and diligent, at least for the first few years. Lesions graded 1 or 2 are, as a rule, adequately dealt with by wide surgical removal; in selected cases the application of radium may be the treatment of choice. However, the observations of the surgeon should govern the radiotherapist in outlining the treatment or follow-up observation.

8. Inflammatory as well as other nonmalignant processes form a productive field of therapeutic investigation. Success in treating a limited number of lesions has shown clearly the possible good to come from treatment. As time passes other nonmalignant lesions will be considered amenable to treatment by irradiation.

9. Radium occupies an enviable position in medicine today. Records of its achievement in the past are satisfactory and the realities of the present are far in advance of anything that was imagined by the early workers in this field. You may be inclined to estimate or calculate its position in the future and, for your guidance, may I sug-

gest to you the great possibility of improvement that will come through coöperation and coördination of effort. The basis for the treatment is sound. However, present interpretation of the best way to utilize the substance may only approach its real possibilities. Earnest effort will do much to make treatment by radium a useful and valued procedure in the science and art of medical and surgical practice.

CALCULATIONS OF TISSUE DOSAGE IN RADIATION THERAPY*

(A second report)

By HAYES E. MARTIN, M.D., EDITH H. QUIMBY, M.A., *and* GEORGE T. PACK, M.D.
Memorial Hospital
NEW YORK CITY

THE investigations reported in this paper have as their purpose the determination of the lethal dose of radiation for various types of neoplasms, and the means by which this dose may be consistently produced in given tumor masses. We realize that several factors other than the quantity will modify the effect of radiation upon a neoplastic mass. Among the most important of these are the rate of administration, the treatment interval, the quality of the radiation and the reaction of the tumor bed. However, these factors remain practically constant in our clinic, and in the present discussion we will disregard all except the quantity and treatment interval.

The difficulty in calculating depth doses from various applicators, both external and interstitial, has led to the common practice of expressing radiation dosage in terms of the physical factors of the radiating source (strength, distance, time, filter, etc.), or in terms of the quantity of radiation delivered at the skin portal. A statement of the physical factors involved in a treatment we will call the "applicator dose." For our purpose, however, it is necessary to calculate the quantity (or intensity) of radiant energy delivered to any point within tissue, and this quantity we will call the "tissue dose."

Due to the lack of uniformity of distribution of radiation throughout any volume of tissue treated therapeutically, the tissue dosage cannot be truly stated for a mass, but only for some point within it. This lack of uniformity of distribution is not of great significance with heavily filtered external radiation at a distance, but is of great importance with interstitial radiation, due to the great variations of intensity within the short distances involved. Therefore, since for practical purposes we cannot irradiate masses with a uniform intensity, that point which receives the minimum quantity will determine the effectiveness of the treatment. If the cells at this point are insufficiently irradiated, the tumor will recur, even though other portions have received several times the lethal dose. Since we are most concerned with this critical point, *we consider the tissue dose of any mass as of that point within it which receives the smallest quantity of energy.*

For our unit of measurement we have chosen the skin erythema dose.† This unit is not entirely satisfactory but we believe that no better one is available at present. The r-unit cannot be used, since there is at present no method for determining in terms of this unit the intensities at the extremely short but significant distances involved in the neighborhood of a group of interstitial implants. Furthermore, it remains to be proved whether the degree of ionization of air will be proportionate to the biological effect for all wave lengths and types of radiation.

Having decided upon a unit of measurement, and agreed that, for practical purposes, we must apply it to the point of minimum intensity within a mass, it next becomes necessary to calibrate all applica-

† We define this as the amount of radiation which if delivered at one sitting will, in 80 per cent of the cases treated, produce a faint bronzing or reddening of the skin in from ten to twenty days and in the other 20 per cent will produce no visible effect. We admit that this unit is not entirely satisfactory, but believe that there is not a better one available at present. It is not open to the objection to the usual erythema dose, of a high degree of uncertainty in its determination. Whereas the amount of radiation necessary to produce a certain degree of reddening, according to any definite color scale, may vary by more than 50 per cent in different individuals; the threshold dose, determined by tests on a large number of individuals, will probably not vary by more than 10 per cent.

* Read at the Fifteenth Annual Meeting, American Radium Society, Detroit, Mich., June 23–24, 1930.

tors used so that the tissue dose be known at all depths below the skin surface and in all sizes and shapes of masses encountered clinically. This determination is relatively easy with external applicators. The applicator dose necessary to produce the threshold erythema can be found by direct experimentation. The percentage of the amount falling on the skin which reaches various depths can readily be determined by means of a water phantom and small ionization chamber. The method is one with which all radiologists are familiar and it needs no description here. The tissue dose delivered in any mass by external radiation may be considered as of that point which lies deepest, or at the greatest distance from the skin portal. The sources of external radiation used for treatment in intraoral cancer at the Memorial Hospital are high voltage roentgen rays, the radium element pack, and, to a much smaller extent, the radon tray. Specifications and depth doses for these applicators are given in Table 1.

Table I

Depth	X-rays 200 kv. 0.5 mm. Cu, 50 cm.	X-rays 175 kv. 0.5 mm. Cu, 30 cm.	Radium Element Pack at 6 cm.	Radon Tray at 3 cm.
0	100	100	100	100
1	99	92	75	62
3	85	73	51	27
5	68	53	36	14
7	52	36	25	8
10	33	20	16	4
12	25	15	12	—
15	17	10	9	—

With interstitial applicators the calculations are much more involved. First, given a standard applicator with a fixed filter (seed or needle), a curve must be obtained, showing the relation of biological effect and distance in terms of the above-mentioned biological unit. This work has been done in the biophysical laboratories of the Memorial Hospital and a complete discussion published.[1] If all neoplastic masses then were spheres, and if it were clinically advisable to treat these masses with one interstitial applicator, the minimum dose for such a mass, or in other words, the tissue dose, would be that delivered at a point at the periphery; a simple matter of applying the above-mentioned curve. But, as a matter of fact, neoplastic masses are not often spherical, and it is neither practical nor clinically advisable to treat all, except the smaller, from one point at the center. It thus becomes necessary to consider the distribution about groups of implants variously spaced. How does the spacing and arrangement alter the effectiveness of a group of implants? Since the number of possible spacings and arrangements of any group of implants is infinite, how may one consistently apply interstitial implants to produce a predetermined dosage?

Our method for calculating interstitial dosage is based on investigations on the distribution of intensity in the neighborhood of groups of implants differently spaced. A full account of these investigations has been published.[2] The results of these experiments may be briefly stated as follows: Considering the implant generally used at Memorial Hospital (the gold seed) as a point, the locus of any given intensity about one implant constitutes a hypothetical sphere with the implant at its center. If two such implants are placed in relatively close proximity, there is no way to arrange them so that the locus of any given intensity will be exactly spherical, except to place them together at one point. Therefore, it is obvious that two implants cannot be logically used to irradiate a spherical mass. The same is true of three implants, since they lie in a plane. The simplest geometrical arrangement about one point is four at the apices of a tetrahedron. Assume that one implant of n millicuries will produce an intensity d at a distance of r. If the same quantity of radon were then divided into 4 implants of $n/4$ millicuries each, how should these 4 implants be spaced about a point, so as to irradiate the largest sphere with at least the given in-

tensity *d*? Our calculations have shown that no spacing will irradiate with at least the intensity *d* at the periphery an appreciably larger sphere than if all the implants are concentrated at the center. The size of the sphere to which *d* is delivered remains practically constant, as the implants are moved geometrically out from the center to a distance of $\frac{1}{2}r$. At distances greater than $\frac{1}{2}r$, a progressive decrease will be apparent in the size of the sphere which can be placed within the isodose limit. On this basis we have formulated the following rule: *A spherical mass is equally well irradiated by a given quantity of radon whether concentrated at its center or subdivided and distributed geometrically about the center, provided that the implants are confined within the inner half of the radius.*

If the distribution curve for the particular type of implant has been worked out in terms of the biological unit, the intensity in terms of this unit is readily calculated with an implant of given strength in the center of a given sphere. Conversely, the strength of implant necessary to produce a given dose at the periphery of a given sphere may be calculated. If implants are geometrically placed within the inner half of its radius, their action may thus be calculated. As a convenience in clinical practice, we have compiled the following table (Table II) of approximate dosages for our most widely used type of implant.

The two principal uses of Table II may be explained briefly. First, when gold seeds containing a known number of millicuries have been introduced into a mass whose

TABLE II

MILLICURIES IN GOLD SEEDS (0.3 MM. GOLD FILTER) REQUIRED TO DELIVER SPECIFIED DOSES TO MASSES OF VARIOUS DIAMETERS

Skin Erythema Doses	Diameter of Mass—Centimeters											
	1.0	1.5	2.0	2.5	3.0	3.5	4.0	4.5	5.0	6.0	7.0	8.0
	Number of Millicuries											
1	0.2	0.5	0.8	1.5	2.0	2.4	2.9	3.4	4.0	5.4	7.0	9.0
2	0.4	1.0	1.6	3.0	4.0	4.8	5.8	6.9	8.0	11	14	18
3	0.6	1.5	2.4	4.5	6.0	7.2	8.7	10	12	16	21	27
4	0.8	2.0	3.2	6.0	8.0	9.6	12	14	16	22	28	36
5	1.0	2.5	4.0	7.5	10	12	14	17	20	27	35	45
6	1.2	3.0	4.8	9.0	12	14	17	20	24	32	42	54
7	1.4	3.5	5.6	10	14	17	20	24	28	38	49	63
8	1.6	4.0	6.4	12	16	19	23	27	32	43	56	72
9	1.8	4.5	7.2	14	18	22	26	31	36	49	63	81
10	2.0	5.0	8.0	15	20	24	29	34	40	54	70	90
11	2.2	5.5	8.8	17	22	26	32	37	44	59	77	99
12	2.4	6.0	9.6	18	24	29	35	41	48	65	84	108
13	2.6	6.5	10	20	26	31	38	44	52	70	91	117
14	2.8	7.0	12	21	28	34	41	48	56	76	98	126
15	3.0	7.5	13	23	30	36	44	51	60	81	105	135

It will be observed that, for diameters greater than 3 cm., this table differs somewhat from the one previously published. At that time we stated that the values for these distances were the results of extrapolation of the dosage curve, and therefore subject to possible revision in the light of further experimental work. The values given at present represent this revision, based upon new evidence from the physical laboratory. It has not yet been possible to extend the actual erythema measurements beyond the 3 cm. diameter, and until this is done the last part of the table must still be regarded as less accurate than the first. It is hoped that eventually erythema tests may be made for these distances and the table presented in final form. However, since the values for diameters up to 3 cm. are known to be correct, and those for larger ones are based upon extensive laboratory investigation, we feel that whatever future revision may be necessary will not be very extensive. We have no hesitancy in recommending this table for practical use.

diameter has been measured, to find the minimum tissue dose which has been given, in terms of the skin erythema dose. In the top row of numbers, find the diameter of the mass. In the column under this number, find the number of millicuries. In the corresponding position in the first column will be found the minimum tissue dose which has been delivered. Thus 20 mc. in a mass 3 cm. in diameter will give a minimum dose of 10 S.E.D. Second, to find the number of millicuries necessary to deliver a specified tissue dose in a mass of a given diameter. Find the diameter in the top row, the dose in the first column; at the intersection of the row and column thus designated will be found the number of millicuries required. Thus, to deliver a minimum of 10 S.E.D. in a mass 3 cm. in diameter, 20 mc. must be used.

In clinical practice tumor masses are not often spherical, but all masses may be considered as lying just within a sphere, or as composed of two or more adjacent or overlapping spheres. A long narrow mass may be considered as being composed of three or four overlapping spheres and each treated individually. This method of dosage calculation is most logically used to decide what applicator dose is necessary to produce a predetermined tissue dose. But provided that accurate measurements have been made, it may also be used to calculate what tissue dose has produced certain end-results in cases treated by empirical methods.

Our first calculations were made on cases which had been treated empirically. In a series of cases of adult intraoral squamous carcinoma,[3] we found that those which were apparently cured had received a tissue dose of between 7 and 10 S.E.D. (skin erythema dose). Although the number of cases was too small to draw definite conclusions, we felt justified in prescribing doses within this range to favorable cases of intraoral adult squamous carcinoma. This method of radiation therapy and the

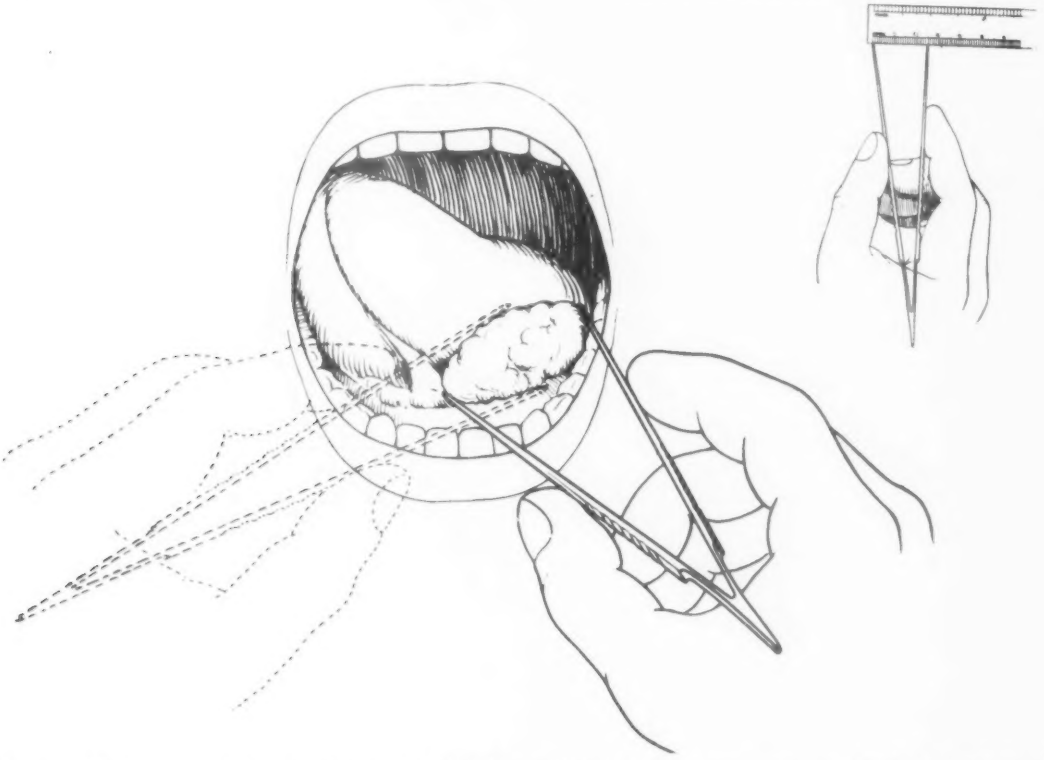

Fig. 1. The primary lesion in the case of Number 39 (H. R.) being measured by thumb forceps used as calipers.

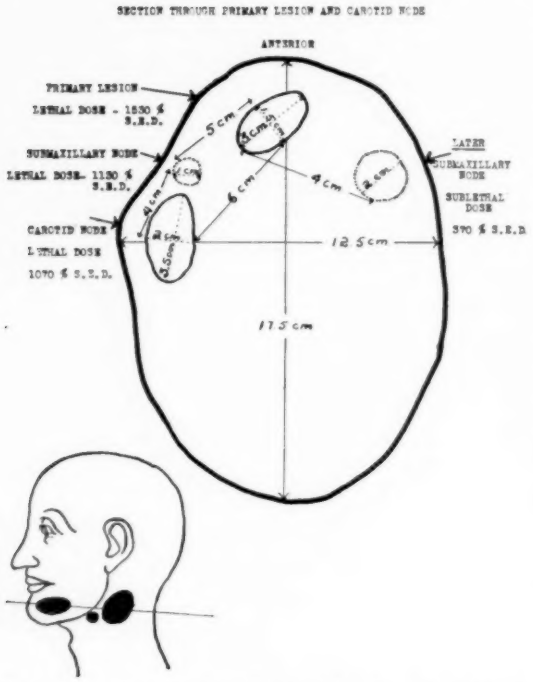

Fig. 2. A cross-section diagram in the case of Number 39 (H. R.) showing location and sizes of the various foci of the disease.

records kept for clinical investigation are perhaps best described by a detailed report of a given case in which, after careful measurement of the size and depth of a tumor, a predetermined tissue dose expressed in units of a skin erythema dose was delivered within a specified time interval.

H. R., male, aged fifty-seven, was first seen on June 5, 1929. He had noted a "sore" in the left floor of the mouth about two months before admission, and some weeks later, nodes in the left side of the neck.

Examination revealed an ulcerated granular lesion in the left anterior floor of the mouth. It was not definitely attached to the alveolar process and was just beginning to infiltrate the under surface of the tongue. The longest diameter was anteroposterior and measured 3 cm. (Fig. 1).

Extending from about the position of the left carotid bulb to the mastoid process, there was an indurated node about 3.5×2 cm. Anteriorly and below this node over the lower pole of the submaxillary salivary gland, there was a second node about 1.5 cm. in diameter (Fig 2).

A biopsy from the primary lesion was reported as "epidermoid carcinoma, Grade III" (Fig. 3).

In order to prescribe treatment in specified tissue dosage, it is first of all necessary to measure accurately all diameters and distances of the various foci of the disease. The most important of these are the actual size of the primary lesion and the metastases, and secondly, their depth from all skin portals and their distances from each other.

The size of the primary lesion and the metastases are measured by a caliper or thumb forceps and centimeter rule (Fig. 1). The depth of the various metastases beneath the nearest skin surface is estimated by the thickness of the superficial tissues, and we have observed at operation that the variation is ordinarily small (between 1 to 2 cm.).

A cross-section outline of the neck and head at the level of the primary lesion and metastasis is next taken by an apparatus, the description of which is published elsewhere in this issue. In many cases only one cross-section outline need be taken which will pass through both

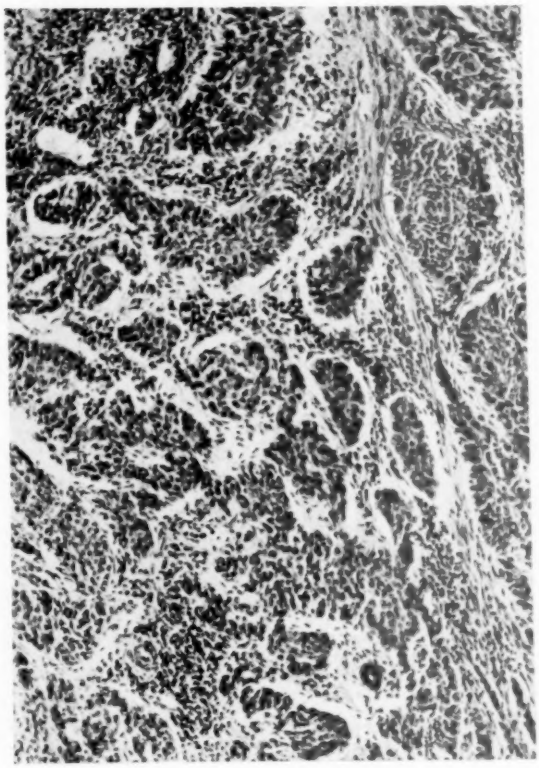

Fig. 3. Biopsy from the floor of the mouth in Case 39 (H. R.), "epidermoid carcinoma, Grade III."

the primary and a single metastasis (Fig. 2). This outline is drawn in actual size, and the neoplastic foci indicated in their correct sizes and positions within the diagram (Fig. 2).

We are now ready to prescribe treatment. From our past experience, we believe that a tissue dosage of 10 S.E.D. should be attempted in all adult intraoral squamous carcinomas, if the applicator doses required seem within the local and general tolerance.

From external radiation alone, we have found it possible to deliver within ten days between 1 and 2.5 S.E.D. to tissues in any part of the mouth, throat, or neck. Given bilaterally, the tissue dose is, of course, largest on the skin and in the superficial tissues, falling off toward the midline at a varying rate, depending on the distance and type of the radiating source. Tissue doses of 2.5 to 3 S.E.D. within ten to twenty days to the midline of the neck by external radiation approach the limit of general tolerance because of the diffuse effect of such doses throughout the tissues of the neck. These doses are justified only if external radiation alone is to be used, and provided that there is definite evidence that the lethal tumor dose is at least this high and no higher.

From the external radiation (Table 1) we may quite readily produce about 2 S.E.D. in each disease focus without unduly injuring the skin. Larger doses of external irradiation would hardly be justified in this case from the standpoint of the general tolerance. The remainder then must be made up by interstitial radiation. From Table II we find that the millicuries in gold seeds necessary to deliver 8 S.E.D. (to bring the total to 10 S.E.D.) would be as follows:

	Diameter cm.	Millicuries Required
Primary lesion	3.0	16
Carotid node	3.5	19
Submaxillary node	1.5	4
	Total	39

Interstitial radiation in this amount (in the neighborhood of 40 mc.) is not always well tolerated and should not be given without due regard to its possible after-effects.

We might well then consider whether the above-mentioned dosage might be modified and still remain rational. The biopsy indicated that this particular neoplasm was more radiosensitive than the average intraoral squamous carcinoma. The metastases might be given smaller doses, but the primary lesion, due to its irregular shape and the tendency of such a lesion to infiltrate beyond its palpable limits, might well be given the full dose, or even somewhat more.

Treatment was, therefore, prescribed according to this modified plan; the primary lesion receiving 25 mc. (12.5 S.E.D.); the carotid node, 18 mc. (7.5 S.E.D.); and the submaxillary node, 2.3 mc. (4.60 S.E.D.); the remainder being made up from mutual effect of the implants in the other foci and from external irradiation.

The various applicator doses and the exact calculations of the tissue doses at the several foci are given in Table III.

From Table III it is seen that the carotid and submaxillary metastases received 10.7 and 11.3 S.E.D. respectively. The primary lesion received 15 S.E.D., a larger amount than its apparent size indicated, but one which in the judgment of the clinician was advisable because of its irregular shape and not entirely distinct borders.

The outcome of this case was very gratifying. The radiation reaction was moderately severe, but was well withstood by the patient who remained ambulatory and attended to his affairs, except for the time spent in receiving treatment. There was regression of all the above-mentioned foci and complete healing without slough in about eight to ten weeks.

In November, 1929 (five months later), a node about 2 cm. in diameter was discovered in the opposite submaxillary triangle (Fig. 2). This was treated by insertion of 10 mc. in gold seeds which delivered 10 S.E.D., followed by regression. The patient shows no evidence of disease at the present writing (June, 1930), seven months following treatment of the recurrence.* The site of the later metastasis in the right submaxillary triangle has been calculated to have received almost 4 S.E.D. at the time of his first treatment. The lethal dose for this particular specimen of intraoral squamous carcinoma is, therefore, shown to lie between 4 and 11 S.E.D. This case illustrates in detail our methods of examination, measurement and dosage calculation in the treatment of intraoral cancer.

Not all cases of intraoral cancer are suited to this type of investigation. The

* Later observations show this patient free from recurrence in March, 1931, sixteen months after treatment of the latest recurrence.

TABLE III

APPLICATOR AND TISSUE DOSES IN CASE NUMBER 39 (H.R.)

Applicator Dose					Tissue Dose											
					Primary Lesion			Carotid Metastasis			Submaxillary Metastasis			Site of Later Metastasis		
					Distance			Distance			Distance			Distance		
Date	Source	Amount	Skin dose (per cent S.E.D.)	Part Irradiated	Through air	Through tissue	Dose (per cent S.E.D.)	Through air	Through tissue	Dose (per cent S.E.D.)	Through air	Through tissue	Dose (per cent S.E.D.)	Through air	Through tissue	Dose (per cent S.E.D.)
6- 5-29	X-rays 165 kv.–30 ma.	150 ma-min.	100	Left submaxillary triangle	30	4	65	30	6	45	30	2	85	30	7	30
6- 6-29	Filter 0.5 mm. Cu plus 5 cm. oil	150 ma-min	100	Left cheek	30	4	65	30	3	75	30	3	75	30	8	20
6- 7-29	Target skin distance 30 cm.	150 ma-min.	100	Left cheek	30	4	65	30	3	75	30	3	75	30	8	20
	Total External						195			195			235			70
6-13-29	Gold seeds; Filter, 0.3 mm. gold	25 mc.		Primary lesion		1.5	1250		6	125		4	300		4	300
6-24-29	Length, 4 mm.	18 mc.		Left carotid metastasis		6	85		1.75	750		5	135		7	
6-24-29		23 mc.		Left submaxillary metastasis		4			5			0.75	460		5	
	Total interstitial						1335			875			895			300
	Total tissue dose						1530			1070			1130			370

primary lesion and any metastases must be capable of reasonably accurate measurement and localization. The treatment given must be confined to a reasonably short period, and the case must be regularly followed over a long period. Our observations have convinced us that the treatment period should be relatively short (within twenty days) and that for adult squamous cancer, tissue doses of 3 to 4 S.E.D. are insufficient, even if given within a very short time (five days). Since the local and general tolerance will not permit a larger tissue dose than 2.5 to 3 S.E.D. to the midline of the oral cavity or neck in ten to twenty days, if given by external radiation alone, such treatment should not be used for intraoral cancer of the adult squamous type.

A year ago we reported[3] before this Society our observations on 10 cases of intraoral carcinoma in which the tissue doses had been calculated. At this time we wish to present an inclusive report of 56 cases in which the period of observation is at least one year, or in which there has been definite proved recurrence (Table IV). Obvi-

TABLE IV

LETHAL AND SUBLETHAL DOSES IN ADULT SQUAMOUS CARCINOMA

No.	Case	Admission Date	Diagnosis	Histology	Treatment Intervals (days)	Tissue Dose		Time Well since Treatment (years)
						Lethal	Sublethal	
1	F.P.	6-15-25	Carcinoma larynx	Epidermoid carcinoma Grade II	27	1200		5
2	B.F.	5-11-26	Carcinoma floor of mouth	Squamous carcinoma Grade II	11	1580		4
3	A.A.	7-18-26	Carcinoma floor of mouth	Squamous carcinoma Grade III	9	925 (node)	540 (node)	4
4	J.M.	8-11-26	Carcinoma larynx	Squamous carcinoma Grade I	5	770		4
5	A.O.	12-3-26	Carcinoma larynx	Squamous carcinoma Grade II	15	1105		3½
6	J.S.	12-3-26	Carcinoma larynx	Squamous carcinoma Grade II	9	880		3½
7	G.Ln	12-17-26	Carcinoma base of tongue	Squamous carcinoma Grade II	16	1305		3½
8	E.B.	5-3-27	Carcinoma floor of mouth	Squamous carcinoma	25	1145 (node)		3
9	J.A.	5-17-27	Carcinoma tongue	Squamous carcinoma Grade II	4	2200		3

TABLE IV (*Cont.*)

LETHAL AND SUBLETHAL DOSES IN ADULT SQUAMOUS CARCINOMA

No.	Case	Admission Date	Diagnosis	Histology	Treatment Intervals (days)	Tissue Dose		Time Well since Treatment (years)
						Lethal	Sublethal	
10	G.Ls	6–13–27	Carcinoma tongue	Squamous carcinoma Grade II	3	875		3
11	E.P.	8– 3–27	Carcinoma floor of mouth	Squamous carcinoma Grade III	4	1230 (primary)	550 (node)	3
12	P.M.	10– 4–27	Carcinoma pharynx	Squamous carcinoma Grade II	18		290	
13	C.D.	1–14–28	Carcinoma tongue	Papillary squamous carcinoma Grade I	24	990		2½
14	J.K.	2–24–28	Carcinoma base of tongue	Squamous carcinoma Grade I	25		375	
15	M.B.	6– 6–28	Carcinoma antrum	Squamous carcinoma Grade II	7	645		2
16	L.H.	6–20–28	Carcinoma tongue	Squamous carcinoma Grade II	10	940		2
17	S.K.	7– 5–28	Carcinoma tongue	Squamous carcinoma Grade II	16	905		2
18	P.G.	9–20–28	Carcinoma base of tongue	Squamous carcinoma Grade II	7	990		1¾
19	J.R.	11– 2–28	Carcinoma tongue	Squamous carcinoma Grade II	14	960 (primary)	320 (node)	1½
20	S.P.	11–20–28	Carcinoma tongue	Squamous carcinoma Grade II	16	1415 (primary)	190 (node)	1½
21	D.R.	11–27–28	Carcinoma cheek	Squamous carcinoma Grade I	11	965		1½
22	M.F.	12– 3–28	Carcinoma tongue	Squamous carcinoma Grade II	7	785 (primary)	145 (node)	1½

TABLE IV (*Cont.*)

LETHAL AND SUBLETHAL DOSES IN ADULT SQUAMOUS CARCINOMA

No.	Case	Admission Date	Diagnosis	Histology	Treatment Intervals (days)	Tissue Dose		Time Well since Treatment (years)
						Lethal	Sublethal	
23	L.R.	1- 5-29	Carcinoma tonsil	Squamous carcinoma Grade II	15	880		1½
24	J.M.	1-15-29	Carcinoma cheek	Squamous carcinoma Grade II	8	1425 (primary)	275 (node)	1½
25	J.D.	1-29-29	Carcinoma tongue	Squamous carcinoma Grade II	21	790		1½
26	B.C.	2- 2-29	Carcinoma floor of mouth	Squamous carcinoma Grade II	12	1015		1½
27	C.R.	2- 4-29	Carcinoma tongue	Squamous carcinoma Grade I	9		225 (node)	
28	R.F.	2-25-29	Carcinoma tongue	Squamous carcinoma Grade II	20		270 (node)	
29	A.F.	3-19-29	Carcinoma pharynx	Squamous carcinoma Grade II	22		220 (node)	
30	R.I.	3-26-29	Carcinoma tongue	Squamous carcinoma Grade II	29	1780		1¼
31	S.L.	4-10-29	Carcinoma tongue	Squamous carcinoma Grade I	8	710		1
32	A.S.	4-18-29	Carcinoma tongue	Squamous carcinoma Grade II	5		235	
33	J.M.	4-19-29	Carcinoma soft palate	Squamous carcinoma Grade II	2	1200		1
34	F.B.	4-27-29	Carcinoma base of tongue	Squamous carcinoma Grade II	10	1225		1
35	W.S.	5- 1-29	Carcinoma tongue	Squamous carcinoma Grade I	6	1345		1

TABLE IV (*Cont.*)

LETHAL AND SUBLETHAL DOSES IN ADULT SQUAMOUS CARCINOMA

No.	Case	Admission Date	Diagnosis	Histology	Treatment Intervals (days)	Tissue Dose		Time Well since Treatment (years)
						Lethal	Sublethal	
36	M.L.	5- 6-29	Carcinoma base of tongue	Adenoid cystic carcinoma	19		200	
37	J.P.	5- 8-29	Carcinoma floor of mouth	Squamous carcinoma Grade II	10	1000		1
38	D.M.	6- 1-29	Carcinoma tonsil	Squamous carcinoma Grade II	33		425	
39	H.R.	6- 5-29	Carcinoma floor of mouth	Epidermoid carcinoma Grade III	9	1070 (node)	385 (node)	
40	M.H.	6- 7-29	Carcinoma tonsil	Squamous carcinoma Grade II	20		420 (node)	
41	D.S.	7-12-29	Carcinoma tongue	Squamous carcinoma Grade II	8	1210	215 (node)	1
42	C.F.	8- 9-29	Carcinoma cheek	Squamous carcinoma Grade I	20		280	
43	I.G.	8-22-29	Carcinoma tongue	Squamous carcinoma Grade II	10		220	
44	M.S.	10-22-29	Carcinoma tongue	Squamous carcinoma Grade II	24		160 (node)	
45	W.M.	11- 2-29	Carcinoma floor of mouth	Squamous carcinoma Grade II	9		280 (node)	
46	E.Z.	11-16-29	Carcinoma cheek	Squamous carcinoma Grade III	17		325 (node)	
47	H.V.	1- 7-30	Carcinoma ethmoid sinus	Squamous carcinoma Grade II	24		100	
48	W.C.	1-28-30	Carcinoma cheek	Squamous carcinoma Grade II	8		275 (node)	

ously it would be impossible to give here full details of measurement and calculation in this large series, but we have attempted to outline the most significant factors from which conclusions might be drawn. In all these cases there has either been recurrence, or freedom from disease for at least a year, a considerable number having been observed from two to five years. We have tabulated the adult squamous carcinomas separately from the transitional cell carcinomas (lymphoepithelioma—Regaud). In order to visualize more clearly the data concerning lethal and sublethal doses, we have summarized Table IV as follows (Table V).

TABLE V

RÉSUMÉ OF LETHAL AND SUBLETHAL DOSES IN 48 CASES OF INTRAORAL ADULT SQUAMOUS CARCINOMA

Tissue dose in S.E.D.	Number of Cases Showing Lethal or Superlethal Doses	Number of Cases Showing Sublethal Doses
1		2
2		8
3		8
4		4
5		1
6	1	1
7	1	
8	3	
9	5	
10	7	
11	3	
12	5	
12+	7	
Total	32	24

In the column of lethal or superlethal doses, it will be observed that the greatest number (15) lie between 8 and 10 S.E.D., those receiving 12 and 12+S.E.D. probably received far more than necessary. In general, the latter were small lesions which may be overdosed with impunity. The smallest lethal dose recorded is 6 S.E.D. which happened to be in carcinoma of the antrum. These are often more radiosensitive than their histology would indicate. About half of these cases were treated empirically before we began to prescribe dosage after measurement, and it is significant that we have not found adult squamous carcinoma to regress under less than 6 S.E.D. The lower end of this scale is the more significant, for, as in all forms of therapy, and especially with such a dangerous agent as radiation, one should strive to accomplish cure by the most conservative and economical means possible. It is on data such as these that we advise the application of doses of 7 to 10 S.E.D. in intraoral adult squamous carcinoma. The higher amount (10 S.E.D.) is to be recommended in all cases if the required applicator dosage is felt to be justified clinically from the standpoint of the patient's local and general tolerance. Doses of 7 S.E.D. are acceptable if the tumor masses are large, requiring massive applicator doses for their production.

The sublethal column of Table V requires little comment, except that it demonstrates the futility of attempting the cure of the average intraoral growth by small or moderate dosage. The higher doses in this sublethal column (4 to 6 S.E.D.) cannot, we believe, be delivered to the midline of the neck or oral cavity by external radiation, except if it be spread out over a comparatively long period. With our apparatus (roentgen rays at 200 kv. and a 4 gram radium pack) we find the limit of local and general tolerance to be about 2.5 to 3.00 S.E.D. in twenty days. Even this dose will prove fatal in some cases because of the diffuse radiation effect throughout the tissues of the neck and throat.

Table VI is an analysis of 8 cases of transitional cell carcinoma (lymphoepithelioma —Regaud). Here, as would be expected in this not clearly understood neoplasm, the lethal and sublethal ranges overlap. This tumor is now universally recognized as being quite radiosensitive. Omitting Case 4 (which was probably overdosed) the lethal range is seen to lie between 2 and 5 S.E.D. It should also be carefully noted that the smallest lethal doses (Cases 2 and 7) were entirely delivered in 9 days, and that the

TABLE VI

LETHAL AND SUBLETHAL DOSES IN TRANSITIONAL CELL CARCINOMA

No.	Case	Admission Date	Diagnosis	Treatment Intervals (days)	Tissue Dose		Time Well since Treatment (years)
					Lethal	Sublethal	
1	E.C.	1-21-26	Carcinoma epiglottis	19	260		Died of lymphatic leucemia after 4 years
2	W.M.	10- 5-26	Carcinoma tonsil	9	195		3½
3	H.K.	6-22-27	Carcinoma tonsil	26	520		No recurrence in area treated, now has metastases to lungs
4	W.S.	7-30-27	Carcinoma tongue	6	1070		2½
5	P.M.	10- 4-27	Carcinoma pharynx	18	290		Died of another disease 1 year
6	P.H.	3-17-28	Carcinoma larynx	34		250	Died of disease 5 mo.
7	W.C.	7-17-28	Carcinoma pharynx	9	145		2
8	R.P.	1-23-29	Carcinoma tonsil	40		260	Died of disease 8 mo.

two cases with sublethal doses of almost 3 S.E.D. were treated over periods of 34 and 40 days respectively. Such observations as these support our preference for short treatment periods (10 days) if possible. We believe that if cure is to be accomplished, the patient's vitality (both local and general) is best conserved by a short treatment period. Undoubtedly the local tolerance of normal tissues is conserved by a long treatment period, but by the same token, vitality of the neoplasm may also be conserved. Cancer, having no function to perform except to live, is at a distinct advantage over normal tissue which must not only remain viable but serve its allotted purpose.

We are convinced that this rational method of radiation therapy is a distinct improvement over the empirical method of dosage estimation. It is only that radiant energy which reaches the tumor mass and the immediate tumor bed, which can possibly be of advantage. A knowledge of the energy given off at the radiating source, or of that falling on the skin portal cannot be of benefit, except as a means of calculating how much of it also reaches the tumor mass.

Radiation therapy applied according to this method will not necessarily accomplish any individual result not possible by the empirical method. A case cured by empirical treatment will be found, on subsequent dosage calculation, to have received at least as much as it would have if previously measured. We believe, however, that our results have been improved by accurate calculation. This is particularly true in two types of cases. We have found that empirical doses for small or moderate-sized lesions are sometimes unnecessarily large, while in the larger masses they were often hopelessly small. We have thus been able to care for smaller lesions with a great deal

less discomfort to the patient, and in many cases of large lesions have recognized the futility of a curative attempt by radiation alone. In these extensive lesions, we have either given smaller palliative doses or resorted to surgery in combination with less radiation.

Our present policy of attempting to deliver 10 S.E.D. if possible and 7 S.E.D. at a minimum to all cases of intraoral squamous carcinoma may be modified after further observation of a larger number of cases. Improvement in technique may also bring out evidence in favor of a smaller dose.

The optimum treatment interval is as yet not definitely settled upon. It may possibly differ according to the radiosensitivity of the tumor. In the average case, we believe that it should be relatively short and that the so-called saturation methods are not logical from the standpoint of our past experience. Any method of irradiation which attempts to conserve the tolerance of normal tissue or to permit its recovery will probably offer the neoplastic mass the same privilege. Saturation methods have not produced curative results in our hands, and we are impressed by the fact that a review of our successful cases shows a preponderance of relatively short treatment periods.

From the histological standpoint, a record of the reaction of a given tumor to a definite tissue dose should be a fruitful field for investigation. Carcinomas apparently identical from the histological standpoint are found to differ widely in their response to radiation. Is this due to a difference in the reaction of the whole organism, or are there histological differences as yet unrecognized? These problems can only be answered after more statistics are obtained from a larger series of cases. We are at present measuring all suitable cases, prescribing definite tissue doses and compiling a larger series, which we trust will permit us to draw more definite conclusions.

This method of treatment and investigation can perhaps best be carried out in the intraoral group of neoplasms due to the comparative accessibility of the tumor masses to localization and measurement. The method is, however, applicable to tumor masses in general, and investigations are being conducted in other departments of our hospital.*

SUMMARY

A method for the calculation of tissue doses in tumor masses is presented and a detailed description of the method is given in a case of intraoral carcinoma.

The lethal and sublethal doses in a series of 56 cases of intraoral carcinoma are reported.

CONCLUSIONS

Successful treatment of intraoral adult squamous carcinoma requires a tissue dose of 7 to 10 S.E.D. if delivered within ten to twenty days. Transitional cell carcinoma (Ewing) or lymphoepithelioma (Regaud) requires 2 to 4 S.E.D. if delivered within the same time interval.

If all foci of the disease can be localized and measured, the necessary applicator dose may be prescribed and administered, so as to produce a predetermined tissue dose.

* The authors desire to express their thanks to Dr. Douglas Quick and Dr. G. Failla for their interest and many helpful suggestions.

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DISCUSSION

Dr. Henry Schmitz, Chicago. The paper of Drs. Quimby and Martin is a very important one as it deals with lethal tissue dosage in oral cancers. They call attention to the applicator dose as distinct from the tissue dose which is of great importance in radiation therapy.

The important part of the paper deals with the determination of a lethal tissue dose based on the histological type of the carcinoma. They refer to two types: the squamous and the transitional or round cell. The latter is more immature and more anaplastic. The authors found that the lethal dose for transitional cell cancers lies between 2.5 to 3 s.e.d., and for squamous cell cancers between 8 to 12 s.e.d. Their erythema dose causes in 80 per cent of the cases reddening within twenty-one days following irradiation, and in the other 20 per cent no reddening at all. If we compare this biological reaction with the skin erythema dose we are using in Chicago we may say that our skin erythema dose is a one and one-half erythema or 150 per cent dose in comparison with the one used at the Memorial Hospital.

It is very interesting to go back in medical literature and find substantiation for the findings of Drs. Martin and Quimby. Probably all of us remember how in 1920 many reports came from Europe in which lethal cancer dosage and lethal ovarian dosage were discussed. The hypothesis was correct but the tissue dosages were sublethal and ineffective. It was in 1920 that Wood and Prime subjected chicken sarcoma to irradiation and found that it took from 5 to 7 s.e.d. to kill the sarcomas, and they concluded that in man it probably takes from 5 to 7 s.e.d. applied to the tumor to bring about the death of the growth. If the conclusion was correct it was up to the therapist to evolve a technique for the safe application of such a dosage.

We were already using a combined technique of radium and roentgen rays in pelvic cancers and oral cancers. It appeared that the skin surface could be subjected to a full radium erythema dose and a full roentgen dose.

In 1925 Quick and Cutler, and also Pfahler and Widmann reported on the combined technique of the use of the roentgen ray and radium in carcinoma. Also they found that one may apply the roentgen erythema dose and a radium erythema dose to the same field.

Today Dr. Martin tells us that the areas of the neck can safely be irradiated with 2.5 s.e.d. This is important because in our work in internal carcinoma we have come to practically the same conclusion.

If the conclusions of Dr. Martin and Dr. Quimby are correct that the quasi superficial growths should receive this large dose, how are we going to reach the carcinomas in the deeper parts of the body? I am convinced from my experience that the necessary dose must be 2.5 s.e.d. in the round cell carcinoma and in the basal cell type, while the squamous cell type necessitates at least twice this dosage.

Another important point brought out is the fact that in calculating the tissue dose the minimum dose applied at any region within the tumor area is the active dose.

Dr. Douglas Quick, New York City. There are two points I should like to emphasize in connection with this presentation.

Dr. Quimby and Dr. Martin recognized, and have so stated in their paper, the various factors which enter into the selection of the optimum dosage—filtration, time, distance and quality of radiation—plus the various clinical factors that enter into selecting the optimum dose for each individual case. This paper, however, deals entirely with intensity. There is no reason, I think, why with time, study, and additional experience we should not be able to write the optimum prescription for a given case, just as we now write a prescription for the druggist. However, in order to obtain the necessary data we must have greater accuracy and we must start somewhere. It seemed that the question of intensity was the best thing to start with, and this paper deals entirely with radiation going into the tumor area. On that score might I say that the figures given represent the intensity at the most remote part of the tumor-bearing area?

The next thing I wish to emphasize is accuracy in making these physical measurements. If we are going to check up our work on any such conditions, and I do not see how we can make progress without doing it, these measurements must be made with extreme care. We cannot just look at the patient and say that the growth seems to be a certain size, or that the metastatic growth seems to be about a certain size. I think it is not enough to take a little rule and make a rough calculation. If you study the tables that have been presented this morning I think you will be impressed by the

very marked difference in intensity, particularly in the smaller measurements.

The relationship of the primary growth to the secondary must be taken into account. We have had difficulty in our clinic in checking up and keeping these measurements accurate for the purpose of this study. I think Dr. Martin's device for the making of the measurements is practical and it seems to fill the bill nicely. It is very ingenious, and you may guess that it had its origin in a hatter's shop. Several of us have been using radium for many years and I think we are inclined to rely upon our judgment in a given case, but I think we need to have our experienced clinical judgment checked up by some such method as this. Not that we wish to have mathematical measurements govern all our dosage, but we should be checked up. I think you will find that in the very small, early lesions we overdose them in many instances and that in larger growths where we think we are using large amounts our dosage is entirely inadequate, which explains at once our failure in dealing with many of those cases.

Dr. Henry J. Ullmann, Santa Barbara, Calif. As this is really a finished paper I do not wish to discuss it, but will ask some questions in order to clarify certain parts in my own mind. One is the correlation of these tables with what I am using so that I may duplicate this method as nearly as possible. Dr. Schmitz spoke of the skin erythema dose and I would like to check with that also. From his statement, I would judge that the skin erythema dose is the same as that Dr. Wood speaks of as the suberythema dose, and which, with heavily filtered high voltage radiation, is 800 r, including the effect of back-scattering. This is the dose that will produce a mild erythema in about 20 per cent, tanning in about 50 per cent, and no effect in the balance. Dr. Schmitz, I take it, is using this 800 r, including scattering, and I wish to know whether this is the correct interpretation of the Memorial Hospital dosage or not.

Another question is whether there has been any trouble with laryngeal reactions in the neck cases. We have always been more or less afraid of edema of the larynx. How much consideration must be given to this?

Dr. Schmitz also spoke of the difficulty of estimating dosage in the deeper tissues. An article was published a short time ago in which they reported in ergs per cubic centimeter, and I would like to have some physicist state whether that is a practical unit for measuring amount of radiation in tissue.

Dr. Sanford Withers, Denver, Colo. I am sure Dr. Martin did not wish to leave the impression that a dose of 7 to 10 skin erythema doses could be repeated. I wish he would tell us quite definitely that it cannot.

The point I wish to make is that normal tissues cannot withstand 7 to 10 erythema doses more than once. If the growth is not entirely eradicated at the first series of treatments, the prognosis is made infinitely worse. I have advocated the following doses since 1922: For basal cell malignancy, 4 S.E.D., for squamous carcinoma of skin and mucous membrane, 8 S.E.D.

You may remember that at the Dallas meeting of this organization Dr. Charles Martin of that city showed a group of cases of carcinoma of the face and lower lip treated with unfiltered roentgen rays, and some were astonished that he gave 7 to 14 skin erythema doses, but gave it just once. I discussed that paper with great pleasure because it was the first published confirmation of my opinion. It is a pleasure to have heard this accurate compilation of dosage for intratumoral irradiation. We will all profit by this.

Dr. J. E. Gendreau, Montreal, P.Q. I wish to congratulate the essayists upon their report which will be helpful for the practical worker. I would like to know the filtration employed and the equivalence between the millicuries and the skin erythema dose and the kind of implants used. I think the dosage and the results are different with different filters.

About the time factor, do the twelve days comprehend the whole action of the implants and applicators?

Dr. G. Failla, New York City. Dr. Ullmann raised the question of expressing tissue dosage in ergs. The erg and calorie are units of energy and so theoretically either one could be used to express the radiant energy which is responsible for the production of skin erythema. Some years ago I read a paper before the Society in which I calculated approximately erythema doses in calories. Any convenient unit can be used to express dosage in tissues or elsewhere. One should bear in mind, however, an important distinction between the work referred to by Dr. Ullmann and the work described in this paper. The author of the paper mentioned expressed radiation absorbed in the tissues in

the ergs per cubic centimeter, whereas in Martin and Quimby's paper there is no attempt to express dosage in terms of what is absorbed per cubic centimeter. This was done purposely in order to avoid some serious difficulties which come in when one attempts to calculate the energy absorbed per unit volume of the tissue, particularly when different types of radiation are used.

The average radiologist is more or less prejudiced against the erythema unit, for no two radiologists speak of the same erythema, and when doses given in one clinic are compared with doses given in another, there may be a large discrepancy. However, if the definition of the unit is based on the threshold erythema dose determined by a series of tests on the skin of patients, the discrepancy that can occur is no greater than 10 per cent. Anyone can duplicate this unit if he is willing to go through the same series of experiments that have been carried out at the Memorial Hospital.

Dr. Quimby (closing). Dr. Ullmann is quite correct in stating that our erythema dose is probably about two-thirds of what Dr. Schmitz uses. We have consistently stated that we are using a *threshold* erythema, while I believe that Dr. Schmitz produces a rather sharp reaction with his. This whole question of units is still in a very unsatisfactory state; eventually I hope we can translate our present varied terminology. In this connection I may say that there is nothing intrinsically wrong with specifying dosage in terms of calories per cubic centimeter of tissue. It is simply inconvenient, and at present has no known relation to biological transformations. The main claims for merit for the erythema dose are that it is rather simple to determine, and that it conveys a definite impression to the clinical radiologist. Dr. Gendreau's questions regarding the specifications of our external radiations are answered in detail in the paper as it will be published. In regard to the number of millicuries per erythema, such a relation cannot possibly be stated *except for a given distance from a specified source.* Thus a 2 mc. seed delivers 10 erythema doses at a distance of 0.5 cm., 2.5 erythema doses at 1 cm., 1 erythema dose at 1.5 cm., etc. A table will be published giving the doses delivered by different seeds at various distances.

Dr. Martin (closing). Dr. Ullmann has asked about the irradiation effect on the larynx, such as edema, and Dr. Schmitz has brought up the question of the limit of the tissue dose to the midline of the neck delivered by external irradiation. The tissue dose to the midline of the neck given by external irradiation within a period of three weeks should be limited to about 2.5 to 3 s.e.d. The chief reason is that this dose produces a general and diffuse irradiation effect throughout the tissue of the neck. Such doses produce an apparent alteration in the function of the tissues which comprise the neck, so that tissue doses of 3 s.e.d. or more will be fatal in some cases. One of the effects of such doses is, of course, edema of the larynx. We do not mean that 2.5 to 3 s.e.d. will cause immediate death of all tissue. The greatest danger of such doses is the general and not the local effect. We have given more than 2.5 s.e.d. to the midline of the neck and the patients have survived, but usually after such a dose is given, the patient must be forcibly fed by a nasal tube. He will be quite sick for a couple of weeks and must be treated accordingly.

Dr. Withers has brought up the question of repeating these doses. They may not be repeated if given over a large volume, such as the whole tongue or the whole neck. However, if the dose of 2.5 to 3 s.e.d. is given to a definite mass, as for instance in the tongue 1.5 to 2 cm. in diameter, it may be repeated if there is recurrence, and in such case there will invariably be local slough. In order to confine the dose to such a small volume, it must, of course, be given by interstitial irradiation. Normal tissue will probably not survive two such doses.

Vol. XXV, No. 4

MIXED TUMORS OF THE PAROTID GLAND*

By EDWIN A. MERRITT, M.D.
WASHINGTON, D.C.

MIXED tumors of the parotid gland are usually mildly malignant new growths, occasionally found in the other salivary glands, buccal mucosa and about the face.

Frequency. Pfender[14] quotes Bohme as stating that 90.51 per cent of 411 collected salivary tumors were of the parotid. Schreiner and Mattick[16] report 66 salivary gland tumors in 6,695 patients accepted for treatment of malignant disease at the State Institute for Malignant Disease, Buffalo. The parotid was involved in 45 of these. Quick and Johnson[15] report 59 cases of mixed tumors of the parotid from the Memorial Hospital, New York City, during the years 1918 to 1921. Sistrunk[17] reports 103 over a five-year period from the Mayo Clinic.

From these figures it may be seen the condition is not uncommon.

Sex and Age. These tumors are common to both sexes, occurring in all ages but more frequently seen from the third to the sixth decades.

Symptoms and Diagnosis. As a general premise, a new growth of the parotid is sufficient ground for diagnosis, the first indication being a painless, well-defined mass, with rounded or irregular outline, to which attention is often attracted by chance. It may remain stationary for a long period, and then without warning develop rapidly, invading adjacent structures, with consequent pain, difficult mastication and deglutition; also facial paralysis. Some cases are rapidly fatal, death having been known to result within a year.

Differential Diagnosis. Rare instances of syphilis, tuberculosis, and actinomycosis of the parotid are reported. Ordinary laboratory procedure will establish a correct diagnosis when there is any question. Primary carcinoma and sarcoma occur but their differentiation is not a matter of importance, the treatment being the same. However, carcinoma is clinically quite characteristic.

It is not to be assumed that the clinical diagnosis of mixed tumors is always an easy matter. They are frequently very confusing and errors in diagnosis are bound to occur, as on palpation the impression is frequently gained of lobulation, and the inexperienced examiner may conclude he is dealing with a lipoma.

Anatomy and Embryology. The parotid, the largest of the salivary glands, extends from the root of the zygoma to the angle of the jaw. Stensen's duct, which drains the gland, opens opposite the crown of the upper second molar. The gland bears a close and intimate relation to the 7th cranial nerve.

Development in fetal life proceeds from a downgrowth of the pre-auricular epithelium and not from an outgrowth from the mouth. The styloid process is derived from the second visceral fetal arch and the gland in early life has a direct relation with the Gasserian fissure. These developmental characteristics offer a probable source of embryonic tumors.

Structure. Bland-Sutton[4] admits that "tumors of the salivary glands are a pathological puzzle and a source of much unsatisfactory speculation." The same author states that "structurally these tumors exhibit extraordinary variety containing spindle cells with interspersed islets and tracts of hyaline tissue which is prone to mucoid changes, forming soft fluctuating masses." To further complicate the picture, these tumors often contain actively secreting cells and the imprisoned secretions may consist of serum, gelatinous material, stringy mucous, and cream-like substances. Any or all of these may be found in any individual case.

Ewing[6] recognizes three groups of epithe-

* Read at the Thirty-first Annual Meeting, American Roentgen Ray Society, West Baden, Ind., Sept. 23–26, 1930.

lial tumors of the parotid: (1) benign adenoma; (2) malignant adenocarcinoma and sarcoma, and (3) autochthonous mixed tumors. He concludes that "no single source of mixed tumors meets all requirements. Some are distinctly adenomatous and probably arise from the acini and ducts of the gland, in which they are well incorporated. Others are encapsulated and take the form of basal cell or adenoid cystic epithelioma which probably arise from misplaced embryonal portions of gland tissue." McFarland[11] believes that the accidental sequestration of embryonal cells during the complicated fetal development of the face and neck affords the most satisfactory explanation of the origin of these mixed tumors.

Treatment. The consensus of surgical opinion is apparently in favor of early and complete removal of encapsulated tumors. Sistrunk, formerly of the Mayo Clinic, hastens to the conclusion that "surgery seems to be about the only treatment which can be expected to cure these tumors, radium and x-ray having but little effect on them." He reports 103 cases during the years 1915 to 1919. In this series 18.3 per cent had recurrences and 6.6 per cent were dead. The excellence of his results emphasizes the importance of operating on patients with well encapsulated tumors. Kerr[7] regards the early small encapsulated tumor as strictly a surgical problem. Peple[13] holds a similar view and treats all others by combined surgical removal and radium. No surgeon advocates the surgical treatment of any non-encapsulated growth of the parotid. Abbe[1] (1906) was the first in this country to treat a case successfully with radium. His patient was clinically well after five years. Pfender reported good results by roentgen therapy in three cases recurring after operations. Meret,[12] Berard,[3] and Kirmisson[8] have had success in treating cases with radium. Weil[18] reported one case of seven years' duration; this was treated by insertion of a radium tube into the tumor. The patient remained well, and when reported two years later showed no recurrence. Schreiner and Mattick believe in the removal of encapsulated tumors followed by irradiation, and in the irradiation by implantation with emanation, radium packs, or high voltage roentgen rays, when the tumor is not favorably located for operation

Quick and Johnson reported 54 cases from the Memorial Hospital; 11 of these were considered operable and 43 inoperable. Of these 22 cases were clinically free from disease after four years with 16 improved and 16 unimproved. They maintain that if a case is favorable for excision it is likewise favorable for radium therapy, and the latter does not predispose to recurrence or the production of metastases. In carcinoma of the parotid they believe that radium alone affords a reasonable hope of control or cure and should be the agent of choice on account of the usually acknowledged surgical failures.

Bland-Sutton emphasizes the beneficial effects of radium on parotid tumors and Ewing considers radium of much value, admitting, however, that after surgical interference encapsulated growths do not as a rule recur but others are very prone to return at once or after an average interval of two and a half years. Cumming[5] reports a case of parotid tumor which was removed surgically and 50 mg. of radium implanted in the wound for nine hours; there was no recurrence two years later. Lang[9] believes in the "intratumoral" application of radium. Lynch[10] reports a case of mixed tumor of the parotid type growing from the posterior aspect of the thyroid cartilage. This was treated with radium at three periods, with intervals of about three years. The fourth dose of radium was given a few months after the last treatment. The patient was without recurrence at the time of writing.

Balestra[2] reports 3 cases; one had combined roentgen and radium treatment. The patient remained well for three years and died of cerebral hemorrhage; one received only roentgen therapy, and the third is still under treatment. He believes irradiation is

the treatment of choice in tumors of this nature.

I have treated 10 cases of mixed tumor of the parotid by radium, radon, and high voltage roentgen rays. I and my associates, however, have seen others treated by roentgen rays alone, and in general it is our impression that nothing more than palliation has been accomplished by this method.

In this series 2 patients with primary tumors were treated by implanting platinum radon seeds and are free from any evidence of the disease eight months and two years afterwards.

One case reported by the pathologist as carcinoma, removed by operation, promptly followed by one course of high voltage roentgen therapy, was clinically cured after a lapse of five and a half years.

Five cases recurring after operation have been treated by a combination of seeds, radium needles, and high voltage therapy. Of this group one died from metastasis, two years after instituting treatment for a recurrence in the parotid and in the cervical lymph nodes fourteen years after operation. Another had a portion of the gland, with the tumor, removed in 1921. Superficial roentgen therapy was given elsewhere. Recurrence was prompt following operation, but was held in abeyance by high voltage roentgen therapy until August, 1928, when a large hard mass extended into the mouth and a similar hard, nodular mass at the angle of the jaw in the soft parts. Mastication was impossible, swallowing extremely difficult, and the patient markedly emaciated. Death from starvation seemed imminent. Ten 10 mg. radium needles were inserted into the oral growth for 18 hours plus a full erythema dose of roentgen rays at 16 inch distance, 135 kv., 5 mm. Al filter, to the tumor at the angle of the jaw. Six months later the patient was free from any evidence of growth and was in good health. In another six months recurrence was noted at the angle of the jaw and needles were again used. The patient is still under observation.

The third case recurred promptly after surgical removal of the tumor and lived but a year, notwithstanding the use of seeds, needles, and roentgen rays in maximum amounts.

Of the 2 remaining cases which were recurrent after operation and treated by deep roentgen therapy alone, one is entirely well at the end of five years, and the other is presumed to be dead.

One mixed tumor of the buccal mucosa is included in the above. It occurred in a man twenty-two years of age, and was of twelve years' duration. To the palpating finger it suggested a lipoma. Radon seeds were implanted in the growth with good results. Later the patient was seen by a surgeon who attempted to excise the fibrotic area. The patient now has a sinus communicating with the mouth.

An interesting case not included in this series is that of a male, thirty-eight years of age, who for three months had noted a slowly growing tumor in the right parotid. The surgeon found a non-encapsulated tumor of the parotid. The pathological report was mixed tumor of the parotid. High voltage roentgen therapy in maximum doses was given in the two months following operation. Subsequent to this another tumor appeared near the original tumor, and a final and correct diagnosis of lues was established.

Technique. Treatment by means of radium packs is impossible except in the few institutions where emanation may be secured, or a considerable amount of the element is at hand. Radium in 5 or 10 mg. needles, or emanation in gold or platinum seeds, offers an ideal method of radium treatment.

The seeds may be removable or non-removable, according to the choice of the operator, but in either case they are introduced under local anesthesia directly into the tumor and 1 cm. below the skin. The tumor is "planted" with seeds, allowing 2 cm. or less of tissue between them. It is well to mark off the area involved and make a careful estimate of the number of seeds required. Having done this, the punctured

skin is sufficient guide for proceeding with implantations. When treating with radium needles, the time element is governed by the radium content and the size of the tumor. The precaution of burying the needle perpendicularly and with the eye of the needle below the skin should be carefully observed.

CONCLUSIONS

1. The treatment of mixed tumors of the parotid is largely in the hands of the radiologist, high voltage roentgen therapy being a useful adjunct to radium in these cases, and is generally indicated.

2. While a small encapsulated tumor may be successfully excised, it appears from the accumulated evidence that implanted radium will accomplish equally as good results.

3. A combination of surgical removal and irradiation by either radium or roentgen rays is illogical. If the former is adequate, the latter is superfluous.

4. A failure to destroy the tumor by implanted radium or radon at the initial attempt does not induce the serious complication of increased malignancy which frequently follows inadequate surgical removal. Additional radium treatments may be given until the maximum result is obtained.

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DISCUSSION

Dr. Charles L. Martin, Dallas, Texas. Since my experience is limited I do not feel at all competent to open this discussion. However, I might mention one or two things that may be of some interest to you.

It is my impression that Dr. Merritt quoted Dr. Sistrunk as being radically opposed to irradiation in all types of mixed tumors of the parotid. I have had the pleasure of working with Dr. Sistrunk during the past six or seven months, since he now resides in Dallas, and he has referred several parotid tumors to me during that time. He believes in the surgical removal of small encapsulated tumors, which we rarely see, but is a strong advocate of irradiation for all other cases. He likes to expose the gland for radium implantation but I am not certain that this procedure is always necessary.

It may be worth while to emphasize the fact that a tumor may remain quiescent in the parotid for a number of years and then suddenly begin to grow and take on very malignant tendencies.

As a point worth considering in the differential diagnosis I should like to call attention to changes which may occur in the lymph node

that lies directly over the parotid gland. Metastases from malignant tumors in the nose or posterior pharynx may cause this gland to grow to a considerable size. Sometimes the primary tumor is not at first evident and a tumor in front of the ear should not be called a parotid tumor until the nose and throat are thoroughly investigated.

I have had some very good results and some very poor ones in treating mixed tumors of the parotid, and it is my opinion that they are really mixed tumors in that some of them are made up almost entirely of radiosensitive cells whereas others contain cells that are very resistant to treatment. Although the resistant tumors are relatively uncommon it is always wise to give a guarded prognosis in the beginning.

Dr. Merritt stated that radium could be used externally only where large amounts are available. I do not believe that this is strictly true since I have obtained some very satisfactory regressions using 50 mg. packs over recurrent nodules in an operative scar. This paper offers a most comprehensive survey of a field in which radiotherapy is definitely indicated and I consider it a very valuable contribution.

Dr. Merritt (closing). With reference to Dr. Sistrunk's statements, I quoted from his article in the collected papers of the Mayo Clinic from 1915 to 1919. That was an actual quotation where he said radium and x-ray were of little or no value. Since that time further experience has probably led him to change his mind.

Certainly there is no objection to using a small amount of radium in the form of packs. The only question is where you have large tumors and a number of patients, it is inadvisable because you haven't enough radium to go around. There is no reason in the world, however, why one shouldn't use a 50 milligram or 100 milligram pack, and there is no reason why a patient should be deprived of the benefit of a radium pack if it is indicated.

SUBDURAL HEMATOMA SHOWN BY ENCEPHALOGRAPHY*

By F. G. LINDEMULDER, M.D.
ANN ARBOR, MICHIGAN

PACHYMENINGITIS hemorrhagica interna chronica may be confused with other diseases, and often it is difficult to make a correct diagnosis by a history and examination. Encephalography can aid in establishing the diagnosis and location of the lesion.

Virchow, who introduced the name pachymeningitis hemorrhagica interna chronica, believed that inflammation of the dura mater was the primary cause and that it gives rise to the formation of a stratified membrane on the inner aspect of the dura. He recognized the possibility that the condition might occur spontaneously from trauma to large vessels; in hemorrhagic, valvular or vascular disease; and in hemorrhage through the pia mater from the cerebral cortex. Griswold and Jelsma believe that chronic subdural hematoma and pachymeningitis hemorrhagica interna are the same, clinically and pathologically. Putnam and Cushing found that an apparently insignificant trauma to the head may be followed by symptoms of intracranial pressure due to subdural hematoma.

It is a well-established fact that the degree and extent of post-traumatic cerebral atrophy may be demonstrated by encephalograms. The demonstration of a subdural hematoma by encephalography is rare. Dickerson made encephalograms which were of value in a case of subdural hematoma when there was confusion as to localization and diagnosis.

The case reported is one of pachymeningitis hemorrhagica interna chronica. It is of special interest: first, because the diagnosis and location of the lesion were confusing; second, failure of ventriculography with successful encephalography; and third, successful operative treatment.

R. C., aged twenty, was admitted to the Department of Neurology at the University Hospital on March 15, 1930. He complained of a slight headache. The family history was irrelevant except that his mother had migraine. For the past thirteen years the patient had had sick headaches. On two occasions he was struck on the head, once during the summer of 1929 when he dove into shallow water, striking his head on the ground; and two months later when he was hit on the left side of the head with a baseball. On neither occasion was he unconscious nor did he have any permanent subjective complaints. On February 20, 1930, he had a severe headache and consequently had his eyes examined for glasses. The headaches continued, but were not severe. Following this he developed a psychosis, lost interest in his surroundings, was irritable, and drowsy. He had projectile vomiting and occasionally was incontinent of urine. The patient was never in coma.

On examination he was fully conscious and responded promptly to questions. The pupils were slightly unequal, the left being the larger. The right pupil reacted to light, but the left did not. The ocular fundi showed a neuroretinitis with no measurable swelling of the optic discs. The extraocular movements were normal and there was no nystagmus. There was an asymmetry of the face, the right side of which was smoothed out and flattened, although the angles of the mouth retracted about equally. There was no paralysis of the tongue. The biceps and triceps reflexes were present, equal, and active. Examination of the heart and lungs showed nothing abnormal. The abdominal reflexes were not obtained. The knee and achilles reflexes were present and were more active on the right than on the left. There were positive Babinski and Oppenheim signs on the right, but not on the left. Kernig's sign was absent and there was no rigidity of the neck. The patient's respirations and temperature were normal, while his pulse varied from 46 to 60 per minute. Roentgen studies of the skull showed no evidence of cranial pathology. A lumbar puncture, with the patient lying on his side, revealed a a spinal fluid pressure of 350 mm. of water. The

* From the Department of Neurology, University of Michigan Hospital, Ann Arbor, Michigan.

spinal fluid was xanthochromatic and clear, with 10 cells per cubic millimeter. There was a trace of globulin and a negative Kahn reaction. The colloidal gold curve was 2210000000. No organisms were found on direct examination and the culture showed no growth.

Because the physical findings suggested a left cerebral lesion, trephines were made in the skull in the left frontal and left parietal regions. The cerebral fluid was under increased pressure and the ventricle collapsed, therefore no air was introduced. The dura mater and cerebral cortex appeared normal.

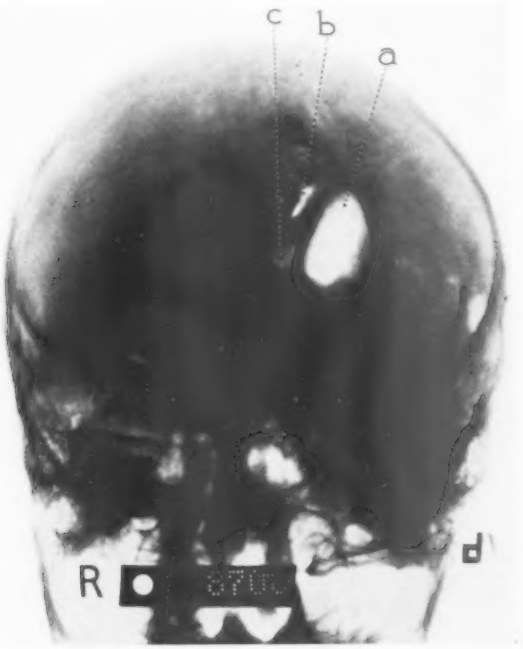

Fig. 1. Anteroposterior view: (*a*) left ventricle dilated and pushed to the left; (*b*) air in cisterna corporis callosi deviated to the left; (*c*) right ventricle compressed and to the left of the midline.

Three days later, an encephalogram was made and 125 c.c. of cerebrospinal fluid were withdrawn and 140 c.c. of air injected. During the procedure, the patient insisted on retracting the head backward. The encephalograms demonstrated in the anteroposterior view (Fig. 1), a markedly dilated left ventricle and a small compressed right ventricle. Both ventricles and the air in the cisterna corporis callosi were pushed to the left, and the right ventricle was pushed laterally past the midline. There was little, if any, subarachnoid air over the right cerebral cortex; the lateral view (Fig. 2) shows a markedly dilated left ventricle and a small right ventricle. The right lateral ventricle was compressed evenly and the pressure appeared to be from above downward. There were two trephine holes present, one in the left frontal region and one in the left parietal region. These studies showed a large diffuse right cerebral lesion.

On March 28, 1930, the patient was operated upon by Dr. Max M. Peet, who turned a large right-sided osteoplastic flap. The dura mater was bluish. A large subdural hematoma covering the right frontal, parietal, and temperosphenoidal regions was removed. The blood clot was thickest in the lateral frontal region where it depressed the brain considerably.

The patient made an uneventful recovery.

Fig. 2. Lateral view: (*a*) trephine markings; (*c*) compressed right ventricle; (*d*) dilated left ventricle.

December 29, 1930, the patient returned for a check-up examination and stated that he had bumped his head in October. He had no complaints. The only positive neurological findings were lost umbilical reflexes. He was advised to continue with his work.

CONCLUSIONS

If trauma to the head was the cause of the meningeal hemorrhage, there was a definite latent period of from three to five months before subjective symptoms developed.

That encephalography can be safely

done in cases of pachymeningitis hemorrhagica interna chronica, has been demonstrated, and in this case 15 c.c. more of air were injected than the amount of cerebrospinal fluid withdrawn.

Ventriculograms failed because of increased cerebral pressure and collapse of the ventricle.

Encephalograms demonstrated the location of the blood clot by the distorted ventricles and absence of subarachnoid air on the side of the subdural hematoma.

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Vol. XXV, No. 4

PEDUNCULATED INTRAGASTRIC TUMOR

CASE REPORT

By C. D. ENFIELD, M.D.
LOUISVILLE, KENTUCKY

THIS case of pedunculated intragastric tumor is reported chiefly on account of the unexpected pathological report of papillary adenocarcinoma in what we were convinced, from the roentgen appearance, was undoubtedly a benign tumor.

The patient, J. R. L., male, white, aged fifty, consulted Dr. Hiram Eggers on account of a history of several months of very vague slight gastrointestinal disturbances which did not fit into any clinical picture.

Dr. Eggers was able to palpate the movable mass in the left upper quadrant and referred him for gastrointestinal roentgen examination.

As the stomach filled, the barium was seen to outline a rounded, radiolucent area in the pars media of the stomach extending almost from the greater to the lesser curvature. Palpation revealed this to be the shadow of a mass which could be moved up and down through a range of several centimeters. There were no filling defects on either curvature and roentgenoscopic observation in various oblique projections failed to show definitely the point of attachment to the gastric wall, though it was thought to be on the posterior surface near the lesser curvature. As the remainder of the barium meal was swallowed, the mass was obscured, evidently by barium coming in in front and behind it so that in the erect posture with the abdomen relaxed, it was not visible roentgenoscopically and was not recorded on the films (Fig. 1). With a cassette pressed against the abdomen the mass was clearly outlined as shown in Figure 2. With the patient prone, the tumor migrated to the upper portion of the stomach and presented the irregular outline shown in Figure 3.

The roentgen diagnosis was pedunculated intragastric tumor, presumably benign and probably attached to the gastric wall slightly posterior to the mid-portion of the lesser curvature.

On November 25 the abdomen was opened by Dr. B. F. Zimmerman and exploration of the stomach revealed the tumor mass attached to an extremely small pedicle on the posterior wall

FIG. 1.

FIG. 2.

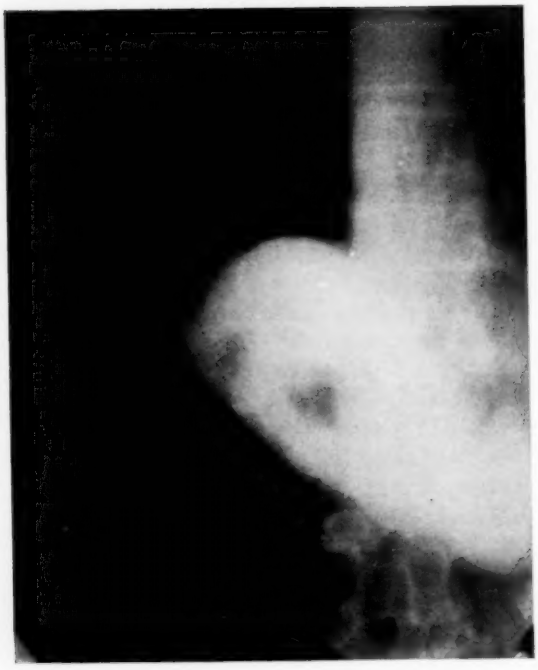

Fig. 3.

in the pars media. The pedicle seemed to be attached only to the mucosa and the growth did not appear to extend into the muscularis.

Pathological report was as follows: Specimen consists of a tumor mass 3 cm. in diameter, rounded and rather soft. The color is dark red. On examination, there are small projections which make the mass resemble a head of cauliflower. There appears to be a short stump on one side.

Microscopic Description. Sections show the mass to be made up of epithelial parenchyma and connective tissue stroma. The epithelium is arranged in a slightly irregular fashion, covering long, delicate, strand-like papillae. The central portion of this is made up of reticular connective tissue in which there are blood vessels and a few infiltrating lymphocytes; at the base of the stroma, there are quite a number of lymphocytes, some eosinophiles and some old blood pigment. One section is taken from the stump of the tumor. Here there are some irregular gland forms, in which the basement membrane is not well constructed and in which the cells are fairly irregular. There are numerous mitotic figures. This picture at the base makes the classification of the malignant tumor very difficult. These tumors, however, are usually of low grade malignancy and if complete removal has been accomplished, there should be no recurrence.

Microscopic Diagnosis. Papillary adenocarcinoma of the stomach (made by Dr. A. J. Miller, pathologist).

Vol. XXV, No. 4

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Publisher: CHARLES C. THOMAS, 220 East Monroe St., Springfield, Ill.

Thirty-second Annual Meeting: Haddon Hall, Atlantic City, N. J., September 22-25, 1931.

THE AMERICAN RADIUM SOCIETY

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Sixteenth Annual Meeting: Philadelphia, Pa., June 8-9, 1931.

Committee on Arrangements: G. E. PFAHLER, Chairman, 1321 Spruce St., Philadelphia, W. S. NEWCOMET, Philadelphia, W. H. SCHMIDT, Philadelphia, W. L. CLARK, Philadelphia, W. H. KRAEMER, Philadelphia, B. P. WIDMANN, Philadelphia.

EDITORIALS

THE SCIENTIFIC BASIS OF RADIOTHERAPY

IN a recent issue of the Lancet[1] it was editorially stated that "There is still an uncomfortable amount of truth in the gibe that the whole of radiology in its radiotherapeutic aspect lacks scientific basis and rests largely on an empirical footing." Casual reading of contemporary medical records bearing on the action of roentgen rays and radium often gives the impression that little is known concerning such action, and the most misleading statements are made and preposterous notions advanced, in spite of the fact that, as far as many phases of the subject are concerned, more or less substantial or conclusive experimental data are available to indicate or to clearly establish the nature of such action. In some cases, indeed, the experimental indications are absolute. In other cases adequate experimental evidence may be lacking, but the clinical data may be sufficient to suggest the probable effect of irradiation. It must be admitted that many problems relating to radiotherapy are still the subject of controversy and that the large number of experiments which have been made have yielded only partial answers to many questions. Nevertheless, the experimental facts already brought to light are sufficiently numerous to provide an adequate, though incomplete, scientific background. Unfortunately, the evidence furnished by experiments on animals and clinical reports has never been brought together, analyzed and correlated, and much of it has been lying on library shelves, buried in medical journals which are seldom read.

Who, after scanning the extensive experiments of Heineke, Warthin, Krause and Ziegler, Fromme, and many others, can say that the action of roentgen rays and radium on leucocytes is not known? How, after examining the experimental reports of Rudberg, Regaud and Crémieu, Bordet, and Arella, can anyone fail to understand the effect of irradiation on the thymus gland or doubt that the small round cells of the thymus are, as Hammar and others have contended they are, lymphocytes? Who, after reviewing the experiments of Lazarus-Barlow and comparing his observations with those of experienced radiologists, cannot agree that, for some unknown reason, the salivary glands are exceptionally radiosensitive? The fact that we do not yet know with certainty every phase of such action and whether all or only an uncertain proportion of the epithelial cells of such glands are affected does not alter the significance of Lazarus-Barlow's description of mucous degeneration of the salivary epithelium. Who, after the thorough experiments of Regaud, and Regaud and Blanc, can deny the unusual susceptibility of the spermatogonial cells of the testis? How, after reviewing the available experimental data, can anyone doubt that excessive irradiation retards the growth of young, rapidly developing bone? Many more examples might be mentioned. It is certain that if these and hundreds of other experiments were better known and closely analyzed no one would think of casting doubt on the scientific basis of radiotherapy. Indeed, to do so would only be to confess ignorance. Unfortunately, for the reasons mentioned, knowledge of the experimental background is not widely diffused, even among radiologists.

The law, rightfully credited to Bergonié and Tribondeau, according to which young or immature cells are more radiosensitive than old or adult cells, has been generally recognized, but how many are familiar with the classic experiments on which this

[1] *Lancet*, 1931, *1*, 141.

conclusion was based? For many years this well-established law has been regarded as the essential foundation of radiotherapy. Indubitable as is the relation of the age of cells to radiosensitiveness, analysis of the numerous experiments made to test the susceptibility of different organs and tissues brings out the even more important fact that each variety of cell in the body has a specific sensitiveness, or rather a specific range of sensitiveness, to radiation. This is not intended to imply that all cells of one kind, such as lymphocytes or squamous epithelial cells, react in precisely the same way to a given dose of rays. A certain measure of variation in reaction must necessarily occur, because different cells of the same kind are struck by the rays while in different stages of metabolism. However, if allowance be made for such variation, and if reaction time be taken as a criterion, the specific sensitiveness of each variety of cell is striking and looms up as the dominant single fact in radiology. Thus, the lymphocytes in the circulating blood, spleen, lymph nodes, intestinal lymph follicles, bone marrow, vermiform appendix, lungs, or anywhere in the body stand out as the most radiosensitive of all cells. Unmistakable microscopic evidence of the action of roentgen rays and radium on such cells was obtained within two hours after irradiation by Heineke, and within fifteen minutes by Warthin. This observation is most significant in relation to the rapidity with which benign and malignant lesions characterized by lymphocytic in filtration or hyperplasia are known to retrogress under irradiation. The same is true of other kinds of cells, although the difference in sensitiveness between several varieties is relatively slight, yet great enough to enable Ewing to identify an endothelial tumor, such as endothelial myeloma, from other neoplasms.

The notion that pathologic cells are more sensitive to radiation than normal cells of the same kind has often been advanced, and numerous examples have been cited. Such difference in susceptibility is undeniable, but in view of the close and constant parallelism between the known radiosensitiveness of different varieties of cells and that of inflammatory or neoplastic lesions, of which the same kind of cell forms the major or essential part, the principle of specific sensitiveness far outweighs any difference in reaction between pathologic and normal cells. Indeed, the specific sensitiveness of each species of cell emerges as the most fundamental fact of radiology and deserves to be recognized as a law. And yet, if we may judge by present-day writings, the existence of such a law and of the experimental grounds on which it firmly rests is not generally known. Moreover, the medical implications of this law are much broader than many radiologists appear to realize, because it constitutes not only the most salient basic principle of radiotherapy, but its application is becoming recognized as a valuable means of differentiating certain varieties of tumor. For instance, when a mediastinal tumor in a child does not diminish in size promptly after moderate irradiation it may be regarded as certain that the tumor is not an enlarged thymus or a growth derived from lymphoid cells. The fact that the difference in sensitiveness between certain varieties of cells is too slight to serve as an absolute means of identification does not affect the principle.

A. U. Desjardins

MARTIN HAUDEK

1880—1931

THE Associated Press Dispatches of March 10 carried the news of the sudden death from heart disease of Professor Martin Haudek, famous roentgenologist of Vienna. Professor Haudek was head of the Roentgen Institute in the Wilhelminenspital, Vienna.

The untimely death of Dr. Haudek at the age of fifty-one represents a great loss to medicine in general and to roentgenology in particular. As early as 1910 he published a very comprehensive report on the study of gastric lesions with particular attention to the penetrating type of ulcers and called special attention to the niche in the formation of gastric ulcer and its roentgen demonstration. His publications were numerous and dealt with many phases of roentgenology, but he is perhaps best known to roentgenologists in America for his work on gastrointestinal diseases. He was a delegate to the Second International Congress in Stockholm which met in 1928 at which time he read a paper on "The Significance of the Changes in the Pyloric Portion of the Stomach." One of his most recent and perhaps the most comprehensive study on the gastric lesions as demonstrated by the x-ray was the lecture which he gave before the British Medical Association and published in the *British Journal of Radiology*, September, 1929. He closed this very comprehensive and detailed discussion of the early diagnosis of carcinoma of the stomach with this prophecy: "We may fairly hope, we may reasonably expect, that it will fall to our lot to attain in the future yet greater success in the diagnosis of the smallest tumors and of malignant changes in the mucosa over and above the results which are even now by no means to be despised. One thing is certain —that none but men equipped with a sound knowledge of pathology, clinical medicine, and radiology can ever help cancer sufferers to the earliest possible diagnosis and cure of their disease." And it may be truly said that perhaps no one in roentgenology has contributed more to a realization of this hope and what we may attain in the future in the way of early diagnosis of carcinoma of the stomach will be predicated upon the brilliant and comprehensive work such as Haudek has done and in his untimely death medicine has lost a keen observer and a brilliant investigator.

SOCIETY PROCEEDINGS, CORRESPONDENCE AND NEWS ITEMS

Items for this section solicited promptly after the events to which they refer.

MEETINGS OF ROENTGEN SOCIETIES*

United States of America

American Roentgen Ray Society
Secretary, Dr. John T. Murphy, 421 Michigan St., Toledo, Ohio.
Thirty-second annual meeting: Haddon Hall, Atlantic City, N. J., Sept. 22-25, 1931.

American College of Radiology
Secretary, Dr. Albert Soiland, 1407 S. Hope St., Los Angeles, Calif.
Annual Meeting: Philadelphia, 1931.

Section on Radiology, American Medical Association
Secretary, Dr. G. W. Grier, Jenkins Arcade, Pittsburgh, Pa.
Annual meeting: Philadelphia, June 8–12, 1931.

Radiological Society of North America
Secretary, Dr. I. S. Trostler, 812 Marshall Field Annex, Chicago, Ill.
Seventeenth annual session: Hotel Jefferson, St. Louis, Mo., Nov. 30–Dec. 4, 1931.

Radiological Section, Los Angeles County Medical Society
Secretary, Dr. John F. Chapman, 209 Professional Bldg., Pasadena, Calif.
Meets on the third Wednesday of each month at the California Hospital.

Radiological Section, Southern Medical Association
Secretary, Dr. W. S. Lawrence, Medical Arts Bldg., Memphis, Tenn.

Brooklyn Roentgen Ray Society
Secretary, Dr. J. J. Masterson, 401-76th St., Brooklyn, N.Y.
Meets monthly on the first Tuesday from October to April.

Buffalo Radiological Society
Secretary-Treasurer, Dr. Joseph S. Gian-Franceschi, 610 Niagara St.
Meets second Monday of each month except during the summer months, the place of meeting to be selected by the host.

Chicago Roentgen Society
Secretary, Dr. George M. Landau, 660 Groveland Park.
Meeting second Thursday of each month October to May inclusive at Virginia Hotel.

Cleveland Radiological Society
Secretary, Dr. A. Srauss, 518 Medical Arts Bldg.
Meetings are held at 6:15 P.M. at the Cleveland Chamber of Commerce Club rooms on the fourth Monday of each month from October to April, inclusive.

Detroit Roentgen Ray and Radium Society
Secretary, Dr. E. R. Witwer, Harper Hospital.
Meets monthly on first Thursday from October to May, at Wayne County Medical Society Building.

Central Illinois Radiological Society
Secretary, Dr. H. C. Kariher, Decatur, Illinois.
Regular meetings held quarterly.

Indiana Roentgen Society
Secretary, Dr. J. N. Collins, Indianapolis, Ind.
Annual meeting each February 22 in Indianapolis.

Milwaukee Roentgen Ray Society
Secretary, Dr. J. E. Habbe, 221 Wisconsin Ave., Milwaukee.
Meets first Friday in October, December, February and April.
Place of meeting designated by the president.

Minnesota Radiological Society
Secretary, Dr. L. G. Rigler, University Hospital, Minneapolis, Minn.
Next meeting: Minneapolis, May 4, 1931.

New England Roentgen Ray Society
Secretary, Dr. Thomas R. Healy, 370 Marlboro St., Boston, Mass.
Meets monthly on third Friday, Boston Medical Library.

New York Roentgen Society
Secretary, Dr. J. Bennett Edwards, Englewood Hospital, Englewood, N. J.
Meets monthly on third Monday, New York Academy of Medicine, at 8:30 P.M.

Central New York Roentgen Ray Society
Secretary, Dr. Robert C. Hall, 258 Genesee St., Utica, N.Y.
Three meetings a year—January, May and November.

Pennsylvania Radiological Society
Secretary, Dr. W. E. Reiley, Clearfield, Penna.
Next meeting, Penn. McKee Hotel, McKeesport, Pa., May 13–14, 1931.

Philadelphia Roentgen Ray Society
Secretary, Dr. Karl Kornblum, 3400 Spruce St.
Meeting first Thursday of each month from October to May inclusive, at 8:15 p.m., in Thomson Hall, College of Physicians, 19 S. 22d St.

Rochester Roentgen Ray Society, Rochester, N. Y.
Secretary, Dr. Camp C. Thomas, 476 Lake Ave.
Meets monthly on the first Friday evening at 7:45 at the Rochester Medical Association Building.

St. Louis Roentgen Club
Secretary-Treasurer, Dr. E. W. Spinzig, 316 Metropolitan Bldg.
Meets first week of each month. Time and place of meetings designated by president.

Texas Radiological Society
Secretary-Treasurer, Dr. C. P. Harris, Houston, Texas.
Meets annually one day preceding the meeting of the Texas State Medical Association.

University of Michigan Roentgen Ray Society
Secretary, Dr. B. D. Harrington, University Hospital, Ann Arbor, Mich.
Meets every Wednesday evening from October to June, at 7:30 o'clock in the amphitheatre of the University Hospital.

* Secretaries of societies not here listed are requested to send the necessary information to the Editor.

Virginia Roentgen Ray Club
Secretary, Dr. Wright Clarkson, 205 S. Sycamore St., Petersburg, Va.
Next meeting, to be announced.

Cuba

Sociedad Cubana de Radiologia y Fisioterapia
Secretary, Dr. Francisco Padron, Enrique Villuendas 64, Havana, Cuba. Meets monthly in Havana.

British Empire

British Institute of Radiology Incorporated with the Röntgen Society
Meets on the third Thursday of each month, from November to June inclusive, at 8:15 P.M., at 32 Welbeck St., London, W. 1., or as advertised.

Electro-Therapeutic Section of the Royal Society of Medicine (Confined to Medical Members)
Meets on the third Friday of each month during the winter at 8:30 P.M. at the Royal Society of Medicine, 1 Wimpole St., London, W. 1.

Section of Radiology and Medical Electricity, Australasian Medical Congress
Secretary, Dr. H. M. Cutler, 139 Macquarie St., Sydney, New South Wales.

Radiological Section of the Victorian Branch of the British Medical Association
Secretary, Dr. Colin Macdonald, Lister House, 61 Collins St., Melbourne, Australia.
Meets monthly at Melbourne during the winter.

Section on Radiology, Canadian Medical Association
Secretary, Dr. A. H. Rolph, 160 St. George St., Toronto, Ont.

Radiological Section, New Zealand British Medical Association
Secretary, Dr. P. C. Fenwick, The Hospital, Christchurch. Meets annually.

Continental Europe

Belgian Society of Roentgenology
Secretary, Dr. J. Boine, Avenue des Alliés, 134, Louvain (Belgium).
Meets monthly on second Sunday at d'Egmonds Palace, Brussels, except in the summertime.

Societe de Radiologie Médicale de France
Meets monthly on second Tuesday, except during months of August and September, 12 Rue de Seine, Paris.

Société Suisse de Radiologie (Schweizerische Röntgen-Gesellschaft)
Secretary for French language, Dr. A. Grosjean, La Chaux de Fonds.
Secretary for German language, Dr. Scheurer, Molzgasse, Biel.
Meets annually in different cities.

Société Francaise d'Electrothérapie et de Radiologie Médicale.
Meets monthly on fourth Tuesday, except during months of August and September, 12 Rue de Seine, Paris.

Association of German Roentgenologists and Radiologists in Czecho-Slovakia
Secretary, Dr. Walter Altschul, German University, Prague, II/52.

Deutsche Röntgen-Gesellschaft (Gesellschaft für Röntgenkunde und Strahlenforschung)
Meets annually in April, alternating one year in Berlin, one year in some other German city. Meets in addition every two years with the Gesellschaft deutscher Naturforscher und Aerzte.
Permanent secretary, Professor Dr. Haenisch, Klopstockstrasse 10, Hamburg, Germany.

Süd- und Westdeutsche Röntgengesellschaft
Meets annually in different cities.

Nord- und Ostdeutsche Roentgengesellschaft
Meets annualy in different cities.

Dutch Society of Electrology and Roentgenology
Holds two meetings a year in Amsterdam, one in the Spring, and one in the Fall.

Societa Italiana Radiologia Medica
Secretary, Professor M. Ponzio, University of Turin, Turin.

Societatea Romana de Radiologie si Electrologie
Secretary, Dr. Nicolae Busila, 44 Elizabeta Blvd., Bucarest.
Meets second Monday in every month with the exception of July and August.

All-Russian Roentgen Ray Association, Leningrad, USSR in the State Institute of Roentgenology and Radiology, 6 Roentgen St.
Secretaries, Drs. S. A. Reinberg and S. G. Simonson.
Meets annually.

Leningrad Roentgen Ray Society
Secretaries, Drs. S. G. Simonson and G. A. Gusterin.
Meets monthly, first Monday at 8 o'clock, State Institute of Roentgenology and Radiology, Leningrad.

Moscow Roentgen Ray Society
Secretaries, Drs. L. L. Holst, A. W. Ssamygin and S. T. Konobejevsky.
Meets monthly on the first Monday at 8 o'clock, the place of meeting being selected by the Society.

Polish Society of Radiology
Secretary, Dr. Jan. Kochanowski, 45 Gornoslazka St., Warsaw. Meets annually.

Warsaw Section, Polish Society of Radiology
Secretary, Dr. B. Krynski, 11 Zielna St.
Meets once a month except in the summertime.

Scandinavian Roentgen Societies
The Scandinavian roentgen societies have formed a joint association called the Northern Association for Medical Radiology, meeting every second year in the different countries belonging to the Association. Each of the following societies, with exception of the Denmark Society, meets every second month except in the summertime:

Society of Medical Radiology of Sweden
Meets in Stockholm.

Society of Medical Radiology in Norway
Meets in Oslo.

Society of Medical Radiology in Denmark
Secretary, Dr. G. Biering, Copenhagen.
Meets on the second Wednesday of each month from October to July in Copenhagen, at 8 o'clock in the State Institute of Roentgenology.

Society of Medical Radiology in Finland
Meets in Helsingfors.

Vienna Society of Roentgenology
Secretary, Professor Holzknecht, Vienna, IX, General Hospital.
Meets first Tuesday each month, October to July.

Orient

Japan X-Ray Association
c/o Orthopedic Surgery, Tokyo Imperial University.
Meets annually in April.
Next meeting to be held April 1, 1931.

Kinki Roentgen-Abend Society
Director, Dr. Prof. Taiga Saito, Ogawaoike Tyoto, Japan. Meets bi-monthly on third Sunday.

TO MEMBERS AND GUESTS OF THE AMERICAN RADIUM SOCIETY

¶The Committee on Arrangements has provided unusual and very attractive entertainment for the Philadelphia meeting. The headquarters for the meetings will be the Adelphia Hotel, 13th and Chestnut Sts. The Scientific meetings begin Monday morning, June 8.

¶At 4 P.M. on that day, buses will be provided to transport members and guests to the DuPont Gardens which are located about thirty miles from Philadelphia. Mr. Pierre S. DuPont has invited the Society to be his guests to visit and have supper in his beautiful gardens. After dark a display of electric fountains which are said to equal or surpass any in the world, will be shown for the benefit of the guests. This will be a very unusual treat which no one should miss.

¶On June 9, the Society will be entertained at luncheon at the Adelphia Hotel by the resident members of the Society, Doctors Pfahler, Newcomet, Schmidt, Clark, Widmann and Weatherwax.

¶On the same day, a sightseeing tour has been arranged for the visiting ladies as guests of the Philadelphia members. This tour will leave the Adelphia Hotel at 10:30 A.M. and will include a visit to the historical points about Philadelphia, following which the ladies are invited by Mrs. G. E. Pfahler to a luncheon at her home. After luncheon, the sightseeing tour will continue to Valley Forge and return to the Hotel.

¶In due time a card will be mailed to each member of the Society with a reply card attached, so that they may signify their intention of attending this unusual entertainment.

G. W. GRIER, *Secretary*.

EIGHTH GERMAN ROENTGEN CONGRESS IN PRAGUE*

The Association of German Roentgenologists and Radiologists in Czechoslovakia held its Eighth Meeting in Prague, on November 8 and 9, 1930. The President was Jaksch-Wartenhorst, the Business Manager, Altschul. The meeting was well attended not only from Czechoslovakia but also from foreign countries as, for instance, Germany, Austria, Russia, and Turkey. The government, the university, and friendly corporations were represented by official delegates.

Principal Subject. The borderline of the normal and pathologic in roentgenography of the lungs.

A review of the entire subject was given by *Fleischner* who covered the field well and illustrated his remarks by the demonstration of very instructive lantern slides.

The clinical side of the subject was presented by *Nonnenbruch* who discussed chiefly tuberculosis of the lungs. He related the development of the tuberculous infection, outlined the various stages, stressing those where clinical and roentgen findings do not run parallel. The primary focus and the involvement of the glands were analyzed, also tuberculosis of the apices which is very common anatomically but is rarely diagnosed on the roentgenogram. Particularly difficult is the interpretation of the early infiltrations as well as that of the late infiltration.

Herrnheiser discussed the technique of the lung roentgenogram and of the roentgenoscopic examination of the chest with particular consideration of the theoretical foundations.

Meller and Menkes reported their preliminary results with a new roentgenologic method of visualizing the lymphatics in the lungs of the cadaver. The best contrast medium appeared to be Umbrathor. They made the injection by means of a fine glass tube directly or in the interstitial tissue. Roentgenograms taken then permitted the study of the lymphatics. In a second paper, the same authors discussed the roentgen visualization of the connective tissue in the lungs. Normal lungs of children were placed in a 5 per cent acetic acid solution. After twenty-four hours, the entire connective tissue is considerably swollen. A comparison of the roentgenograms taken before and after this procedure show that a thick network of connective tissue extends into the periphery of the lungs. The characteristic roentgenogram is due to the varying water content and, therefore, reversible. This explains the rapid change in the living person.

Altschul discussed the hilum in children. A hilum may be considered pathologic if it is denser than usual, particularly if the glands are enlarged. A widened hilum is only pathologic in the sense of being abnormal, but is not diseased. The stage of the process can only be determined in conjunction with the clinical findings because calcifications are relatively rare in children. Very often one finds strings reaching from the lower lobe to the hilum. They correspond in all probability to swollen connective tissue. This impression is supported by the previous paper by Meller.

Adler spoke on roentgen examination of the lungs with the upper body extremely bent forward. This permits the visualization of the entire dorsal part of the lower lobe which is otherwise covered by the diaphragmatic shadow; the posterior part of the diaphragm also becomes visible. Only with this technique is it possible to show the sinus phrenicocostalis, particularly in its dorsal part.

Beutel discussed the topography and morphology of intrathoracic calcifications. In vivo, they must have at least the size of a millet seed before they can be shown roentgenographically. It is possible, however, in a large majority of cases to determine from the form and structure of the calcifications whether they represent a primary lung focus or calcification in the lymph nodes.

Herzog discussed the difficulty of lung

* Report made by Dr. W. Altschul of Prague; translated from the German by Dr. E. A. Pohle, Madison, Wis.

diagnosis in diseases giving similar roentgen findings or in the presence of a combination of several diseases.

Steiner, Teplitz and Schonau discussed the roentgenologic differential diagnosis and morphology of the echinococcus of the lungs and demonstrated films of a case showing roentgenologic details not described before. In the discussion, *Meller* presented two cases where the cyst which was of a round appearance in the beginning flattened out later.

Bonninger demonstrated a testing device for lung roentgenograms which proved of value particularly for the comparison of thorax films and films of the lungs in cadavers. The investigations showed that the value of roentgen examination for beginning tuberculous changes is over-estimated.

Franke spoke on the geometric relations entering into the definition in a lung film. A formula was presented which permits the calculation of the amount of blurring. It appeared that an increase of the focus film distance does not add materially to the clearness of the film and shortening of the exposure time does not improve the image of those parts of the lung which are distal from the film. Other technical devices must, therefore, be employed. An attempt in this direction is a Rotalix tube with the focus moving over the anode.

Hoffmann reported the results of his experiments concerning improvement in roentgenscopy.

In the discussion on the principal subject, *Ghon* pointed out that the term "hilum tuberculosis" must be reserved for changes of the lymph nodes only. For all other pathologic changes, the term "tuberculosis of the hilum area" or "tuberculosis near the hilum" should be given the preference. He also discussed the difference in the term "apex of the lungs" as interpreted by anatomists and clinicians. *Adler* emphasized the difficulty of the diagnosis of hilum tuberculosis and discussed the cavities near the hilum. *Ungar* opposed the differentiation between an anatomical and roentgenologic hilum. *Altschul* asked if the clinicians have not observed a change in the types of tuberculosis during recent years. He has the impression that in earlier years he saw many more cases with pathology in the apices. *Jaksch* reported a case of early apical involvement described by him before the publication of Assmann. As to the quality of the roentgenoscopic image, *Reimann, Steiner, and Gutig* stated in opposition to *Hoffmann* and *Russo* that it is much worse if kenotron apparatus is used as compared with mechanical rectification. *Fleischner*, in his closing remarks, emphasized the great importance of the experimental work of Meller. *Ronnenbruch* closed the discussion with the statement that the clinician will undoubtedly continue to call "apex" that part of the upper lobe extending above the clavicle.

II. *Principal Subject.* Radium therapy.

Werner reviewed this field, beginning with a brief discussion of the physical and technical principles and of the various methods of application. The difference in the effect of radium as compared with roentgen rays was also related. He concluded with an interesting review as to the present indications for radium therapy, considering also the radio-surgical method.

Heiner spoke on radium treatment without filtration by means of radium points which consist of a radium-platinum compound. The results obtained were very good, sometimes almost miraculous, particularly in the treatment of postoperative recurrence in malignant disease.

Palugyay discussed the combined radium therapy of cancer of the esophagus. Out of 32 cases, 2 are clinically cured, 7 are still under treatment and the remaining 23 died

In the discussion, *Amersbach* asked as to the possibility of tissue injury in the cases irradiated before operation. *Altschul* voiced theoretical doubts concerning the application of points in cancer. His opinion was shared by *Fischer*. In his closing remarks *Heiner* stated that he has never seen any systematic reactions.

Therapy.

A. and L. Pokorny recommended the use of lead applicators modeled for each case, particularly for the treatment of lesions in the face.

Samek reported the experience of the Clinic Kreibich, in 200 cases treated with grenz rays. For certain dermatologic diseases, there is a strict indication for the use of grenz-ray therapy. It should also be considered for frequently recurring skin diseases because of its relative harmlessness.

Schiller discussed the rôle of roentgen therapy in the treatment of surgical tuberculosis. Besides the curative effect, roentgen therapy furnishes information as to prognosis and further treatment depending on the type of reaction. It also seems to prevent to some extent ankylosis of the joints. In the discussion, Gutig pointed out that the tendency to heal varies considerably and the results, therefore, are to be evaluated with great caution.

Fried related his experience with the treatment method of Coutard. In spite of favorable preliminary results, a conservative attitude is indicated until more clinics have given this method a thorough trial.

Mannl described a method for treating the sitting patient from below and demonstrated a practical treatment device.

Bones.

Kuh demonstrated a case of severe coxa vara in osteitis fibrosa localisata where the entire right side of the pelvis was involved.

Jaroschy reported three cases of calcaneodynia, two of which showed defects in the upper posterior part of the tuber calcanei; in the third case, several calcified spots were found in the same anatomical location. Obviously these patients had inflammation of the bursa tendo Achillis. The histological diagnosis was nonspecific inflammation.

Kisch demonstrated roentgenograms proving the healing of bone and joint tuberculosis.

Goldmann discussed a few cases of sinusitis in children.

Reiger reported a case of "osteopoikilie" located near the wrist, elbow, or foot joint.

Steiner reported a case of malignant tumor of the right os pubis and discussed the question whether this is a primary tumor or metastasis from a symptomless cancer of the prostate or hypernephroma. *Ghon and Schultze* expressed the opinion that it is a primary tumor.

Abdomen.

Gutig demonstrated a rare duodenal niche which had penetrated into the ligamentum tares. He also showed a case of pseudo-diverticulum in an operated stomach.

Kern presented a case of duodenal ulcer which had perforated into the bile ducts and led to a filling of the gall-bladder with barium.

Mendl demonstrated roentgenograms of a completely inverted stomach.

Porges demonstrated a case of a cecum in abnormal position.

Reimann discussed the roentgen diagnosis of enlargement of the pancreas. This cannot be shown directly on the film but indirectly because of changes in the outlines of neighboring organs, particularly of the stomach and duodenum.

Ungar discussed critically the present roentgen diagnosis of gall-bladder disease in the absence of stones. He believes that the majority of these cases can be classified as to change in size, poor filling, prolonged visualization, and adhesions.

Reiser demonstrated large stones in both pelves of the kidneys and also one very dense shadow in a roentgenogram caused by a kidney stone consisting of pure cystin.

In the technical section, *Strauss, Russo, and Jona* spoke on problems concerning the ionization chamber in dosimeters and the construction of transformers with particular consideration of diagnostic apparatus for high milliamperage.

MINNESOTA RADIOLOGICAL SOCIETY

The midwinter meeting of the Minnesota Radiological Society was held February 14, 1931, at the Minnesota Club. St. Paul, Minnesota. The following program was presented:

"Round Table Discussion of Cases of Diseases of the Bones and of the Thorax." Conducted by Dr. R.G. Allison, Minneapolis.

"Round Table Discussion of Cases of Diseases of the Gall-Bladder and of the Gastrointestinal Tract." Conducted by Dr. John D. Camp, Rochester, Minn.

"Roentgenologic changes seen in Cases of Boeck's Sarcoid and Related Lesions." Dr. S. A. Morton, Rochester, Minn.

"A Correlation of the Various Factors Involved in the Classification of Chronic Arthritis." Dr. M. J. Shapiro, Minneapolis.

"Pulmonary Metastases." Dr. Eugene T. Leddy, Rochester, Minn.

"The Medical Histories of Cases of Carcinoma of the Stomach." Dr. Jacob Sagel, Minneapolis.

The next meeting of the Minnesota Radiological Society will be held on May 4, 1931, at Minneapolis, Minnesota.

The following communication from the February, 1931, number of the *British Journal of Radiology* will be of interest to American roentgenologists who anticipate attending the Third International Congress in Paris in July:

"*To American Radiologists*

"In connection with the Third International Congress, the Council of the British Institute of Radiology extends to all American Radiologists who are proposing to attend the Congress a cordial invitation to make full use of the facilities and amenities of the Institute during their stay in Europe. Letters may be addressed, if desired, c/o the Institute, 32 Welbeck Street, London, W. 1, and visits will be arranged and appointments made by the Executive. The Institute is situated in the heart of the medical centre of London, and is in convenient proximity to many tube and 'bus routes. It is hoped that American Radiologists will not hesitate to regard the Institute as a convenient 'base' while they are on this side of the Atlantic."

"*The Cambridge Diploma*

"In view of various rumours as to the discontinuance of the Cambridge Diploma in Medical Radiology and Electrology, we would draw attention to the following Recommendation which was sent from the Faculty Board of Medicine to the Senate on November 11, 1930, and was passed by the Senate at a Congregation held December 19, 1930.

"'The Faculty Board have had under consideration the Annual Report of the Committee for Medical Radiology and Electrology, as well as other information relating to the Diploma. The Board are convinced by the evidence laid before them that the Diploma continues to meet a real need, and that the standard of the teaching and of the examination is satisfactory. The financial position also is satisfactory.

"The Board therefore are of opinion that the Diploma should be re-established for a period of three years, but that, in view of the rapid growth in allied subjects, the position and scope of the Diploma and the arrangements made with the British Institute of Radiology should be reviewed before the expiration of that period.'

"Dr. A. E. Barclay has been re-appointed University lecturer in medical radiology and electrology."—*Brit. J. Radiol.*, Feb., 1931, *4*, 49.

DEPARTMENT OF TECHNIQUE

Department Editor: Robert B. Taft, 105 Rutledge Ave., Charleston, S. C.

PRINCIPLES UNDERLYING THE GRID DIAPHRAGM WHICH LIMIT ITS FORM AND EFFICIENCY*

By HOLLIS E. POTTER, M.D.
CHICAGO, ILLINOIS

IT IS an entire waste of time to talk about changes in grid form without assuming at the start that a moving grid is made to move with a smooth, uniform motion. By this is meant not a motion approximately smooth but one as smooth as it is reasonably possible to produce. This calls for a constant driving force and good bearings.

The reason for this critical requirement is the amazing ease with which the grid strips record their shadows on the film during the slightest hesitation in grid movement. This tendency is seemingly far greater than would be expected before experimentation. At the end of this article is outlined an experiment easily done which records in a convincing and permanent manner the degree of uniformity of motion of any grid throughout a single stroke of its transit.

Another basic consideration in grid construction is the thickness of opaque material used in the strips composing the complex. They may usually best be made of lead with a small mixture of tin, as thin as possible yet thick enough to perform their function of absorbing scattered rays. It has been found by engineers that three or four thousandths of an inch is a thickness quite adequate.

I. *Résumé of Effective Features in That Form of Grid Described in 1917–1920 as a Portion of Cylindrical Shell.*

(*a*) In this grid the tube focus occupies a position coinciding with the center of grid curvature and the center of grid motion.

(*b*) The parallel lead strips are so placed that the plane of each cuts the operating center and this condition persists during any long or short movement.

(*c*) This construction allows a wide range of tube placement, since it can be shifted without penalty along the entire line constituting the center of cylindrical shell.

(*d*) The continuous alignment of metallic strips during motion does not restrict the amplitude of motion and allows minor violations in tube placement without penalty of line formation.

These features recommend the cylindrical slotted form as most fully satisfying the requirements for efficiency and invisibility and at the same time giving great flexibility in operation.

II. *Résumé of Wilsey's Data on Number of Scattered Rays Present and the Efficiency of Grid Diaphragm. Data on Definition.*

Wilsey brings out the startling fact that beneath 6 inches of scattering material the ray mixture emerging ready to act on a film is composed of 83 parts of scattered radiation and only 17 parts of direct, or approximately 4.9 to 1. And beneath a thicker body of scattering material the ratio is still higher, for below 10 inches of water the ratio of scattered to direct has risen to 11.5 parts scattered to 1 part direct.

He shows that the percentage efficiency of the Bucky diaphragm depends upon grid ratio. In a grid having slots six times as deep as they are wide the absorption of scattered rays is 89 per cent. In a grid of

* This is a second article in a series on grid diaphragms. A third will appear in May, entitled "Analysis of the Flat Grid, and some less Excentric Forms."—Ed.

5 to 1 ratio the efficiency is 86 per cent. A ratio of 4 to 1 eliminates 83 per cent of the scattered rays and a grid possessing the very low ratio of 2½ to 1 still absorbs 76 per cent of the scattered rays present.

This high percentage efficiency shown even in coarse grids of low ratio is especially gratifying and must be emphasized as the one strong point arguing in favor of grid technique.

Wilsey's determinations on loss of definition when the object is far separated from the film by waste space above or below the grid are to be expected. His table shows that when wire meshes were placed 2 inches above a film, the definition as measured by the fineness of mesh that could be recognized on the film was half that recognizable at 1 inch.

III. *Penalties for Improper Tube Placement. When Does Disalignment Produce Lines?*

Even in a grid diaphragm so designed that the grid form is that of a cylindrical shell with strips parallel and placed so that the plane of each cuts a central point or line called the operating center, there is always a chance for producing lines on the film when the tube has faulty placement so that its focus lies outside this designed center.

(*a*) When tube focus is kept in the correct central line but is at a considerably greater or less distance from the grid than intended.

Under these circumstances the film zone under the center of the grid will receive full exposure whereas toward the lateral edges of the film the exposure will be reduced in intensity by absorption of direct rays in the faces of the metallic strips and in addition there will be fine or coarse shadows of the grid strips. This occurs whether the tube is operated from a point too far or too near the grid. It proves that grid shadows may be produced by disalignment of grid strips as well as by faulty movement of grid.

(*b*) When the tube focus is displaced lateralwards from the designed operating center, but still at designed distance there comes a point where the disalignment of grid strips (with reference to roentgen rays) is sufficient to cause visibility of grid shadows. In this case the disalignment is the same for each and all grid strips and the lines on the film are as noticeable over the central zone as at lateral edges.

(*c*) A combined faulty placement of tube focus so that its distance and its centering are both wrong gives a combination of above effects on the film.

(*d*) The amount of disalignment permissible before the grid strips begin to give visible shadows on the film is subject to experimental demonstration. We know in advance from experience that in lateral displacements (across the strips) the shift used in stereoscopic roentgenography usually results in visible lines on at least one of the films in a pair. Practical experience has also taught us the fact of line penalty from faulty distance in tube placement.

The maximum disalignment without penalty depends first upon grid ratio, the higher the ratio the smaller the angle.

Secondly, it depends upon the point in grid movement at which the exposure stops. It might be said that one grid cycle is its passage over the film of a distance equal to one slot-width. Should an exposure be limited to any exact number of cycles the intensity of line effects on film should be at minimum. With the ordinary hit-or-miss exposure the probability of completing an exact number of cycles is indeed small, and the over-fractions are largely responsible for the streaks of light and shade known as "corduroy."

Caldwell emphasized this principle in his "start" and "stop" device as applied to a coarse Bucky grating. With present fine grids it would of course be somewhat impractical.

Experiment. To test out what might be called the maximum average angle of allowable disalignment with a normally curved grid, set up apparatus with the tube focus at designed center of operation. Be-

fore exposure shift the tube one-half inch out of center in a direction across grid strips but at no different distance from the grid. Make a series of exposures, each time moving the tube half an inch farther out of center in the same direction. After finding the point where lines first appear on the films make further exposures at points within the last half inch of shift for better accuracy. From this point to the grid center the angle sought is that formed with the radius of curvature. It will probably be about 3° if using a grid of 1 to 6 ratio at 25-inch distance.

Another method is to construct a special flat grid of strips parallel and all placed in an exactly vertical direction. When this grid is moved smoothly across the film during exposure one obtains no lines in a zone immediately beneath the tube focus. A little distance out from each side, however, lines begin to appear and from the point of their first appearance one can determine the angle of maximum disalignment without penalty.

In either of these experiments the allowable angle of disalignment will be found smaller when using plain films than when made through bony structures for the reason that finer lines can be detected when no structural shadows are present. More concerning probable line formation will be brought out in the next issue.

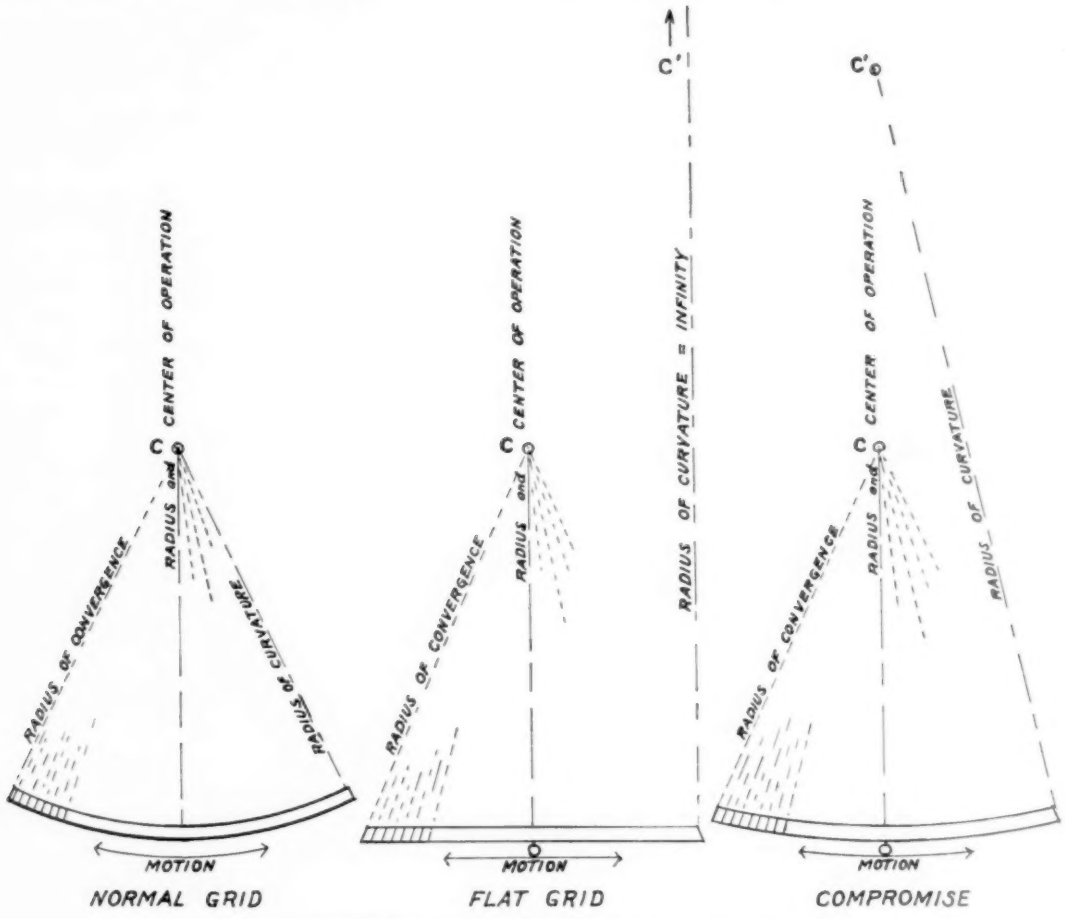


Fig. 1. Graphic illustration of concentric and excentric grids.

IV. *Reasons for Changes in Grid Form.*

For the special examination of certain anatomic parts, there have been developed special types of exposure apparatus,

quite an improvement over apparatus of more universal character. Should it be desired to incorporate into such special types the grid diaphragm principle, our large cumbersome units will of course be unsuitable. Where the anatomic part is small, a grid diaphragm of very small size and scope might answer well.

For certain anatomic reasons in designing special apparatus it might be advisable also to alter the form of the grid. This will be found to be justified if in so doing the altered form gives good efficiency and lies well within the limits of disalignment and probable line formation on films.

It is surprising that but a few such adaptations of the grid principle have been made in the last decade. Most such changes would be expected to compromise some factors in grid efficiency or operating flexibility but be found quite effective for the particular problem at hand. So far the changes from original grid form have been limited mainly to the building of flat grids and their incorporation into flat-topped tables for all-purpose usage. The obvious reason for this change is and always has been the greater all around convenience of a flat as compared with a curved top table.

V. *Effects of Change in Grid Form.*

Any such grid of changed form should be analyzed and checked against a known standard. Its final effectiveness, aside from the standpoint of convenience and flexibility, should be expressed in terms of:

1. Its primary efficiency or percentage of primary rays actually transmitted through to the film.

2. Its percentage efficiency in absorbing scattered radiation.

3. Its ability to give good definition.

4. Its tendency to line formation on films.

If upon analysis it is not too far compromised in its efficient points and has more convenient size and form for any special use then it may be considered a definite improvement.

VI. *Geometric Conception of Various Grid Forms.*

It seems advisable at this point to view the possible changes in grid form from a slightly geometric standpoint and to define a few terms that could be used to advantage. As a standard for comparison, the writer has dared to allude to the curved form of diaphragm described in 1917–1920 as a normal grid. This is justified only because in this form no disalignment of strips may occur during motion.*

Since roentgen rays proceed radially from the focal point of a tube this central point may be called the *center of divergent rays* or the *operating center.*

The *center of convergence* of all metallic strips of the grid is the point toward which they converge.

The *center of curvature* of the grid itself must often be mentioned separately. The radius of curvature of a normal curved grid is also its designed operating distance. A flat grid has no finite radius of curvature.

The *center of movement* is of course the point about which the grid is made to rotate.

Practically speaking, one need consider but two main centers, for the reason that the center of divergence should always be made to coincide with the center of convergence. Similarly the center of curvature should be the center of motion. The dissociation of centers likely to be suggested in a change of grid form is therefore a separation of the first two from the last two. It would take space longer than this article to prove that there can be no advantage in slanting lead strips toward any other point than the intended operating center. There is also no demonstrable reason for moving grid diaphragms along any line other than their line of curvature.

* The spiral form of flat grid is purposely not mentioned in this study since it introduces factors not common to the parallel strip types. It is a normal grid at all points except the exact center where it is a little difficult to terminate the lead without giving a "center spot" on the film. Because it gives disalignment on any displacement of operating center, it lacks flexibility in use. Its most superior feature is that it can be kept continuously in rotary motion and one can "cut in" with an exposure without attention to the grid movement.

Whenever the claim is made that a grid designed to operate at 25-inch distance gives less tendency to line formation when used at 35-inch distance it can be concluded that the grid design was not faithfully carried out in the making.

In a flat grid of strips parallel the center of best operation is established by the convergence of grid strips while the centers of curvature and motion lie at infinity.

The flat grid therefore exemplifies a high grade dissociation of centers and presents problems of disalignment calling for an analysis of its primary and secondary efficiency, its definition, and its tendency to line formation on resulting films as outlined in Section v.

Now between the normally curved and the flat form (with strips parallel) there might be designed a number of slightly curved grids possessing a rather high radius of curvature but made, by inclination of strips, to operate at a conveniently shorter distance. Thus the curvature and movement might be an arc of 75-inch radius whereas the operating center and point for convergence of strips lie at 25 inches. Such excentric grids will be found to stand as a compromise between the normally curved and the flat. Such grids must not be confused with those built for long distance operation in which all centers coincide. These have just as normal characteristics as the normally curved 25-inch grid and will give improved definition.

The next installment will attempt to analyze the factors concerned in the flat and less excentric grids, prove the exact causes of the grid shadow lines on film, and introduce a new method for avoiding this disagreeable penalty of disalignment.

NOTE: *Experiment* to determine uniformity of motion in moving grid apparatus of the parallel slotted type.

After removing the cover from the apparatus so as to expose the grid itself, place upon the grid a flat piece of flat lead, say 4 by 8 inches. This rectangular piece of lead has been prepared by making a narrow smooth saw-cut part way across its center. Place the lead upon the grid so that the saw-cut coincides with any of the slots between central grid strips. It can now ride along on the grid during movement. Place now a small film beneath the grid so that roentgen rays passing through the saw-cut will strike the film during the entire motion. Make an exposure through the entire stroke of the mechanism using a moderately small quantity of roentgen rays.

The result on the developed film will be a delicate record of any periods of fast or slow motion. Any abrupt irregularities, etc., will give a "picket fence" effect. Gradual acceleration or retardation is excusable as they will give no lines in practical use. In fact, the test is so delicate that minor variations in the consecutive reduction of silver on the film will be visible in using mechanisms quite adequate for practical work. In my original experiments uniform discharge of roentgen rays from a gas tube could not be depended upon so a single strip of wood separating two metallic strips of the grid was removed and the exposure made by a ceiling incandescent light upon a plate in a plate holder after removing the slide.

This experiment serves to differentiate between obnoxious lines on the film caused by faulty movement and those caused by disalignment of grid members.

Vol. XXV, No. 4

A NEW POSITION USED IN ENCEPHALOGRAPHY

By R. W. WAGGONER, M.D., Sc.D., *and* DANIEL M. CLARK, M.D.
University Hospital
ANN ARBOR, MICHIGAN

ENCEPHALOGRAPHY has won a place as an important aid in the localization of brain tumors. It is also of considerable value in the diagnosis of other intracranial conditions. It is, however, a relatively new procedure, and is therefore subject to variations and improvements in technique. We wish to describe a position which we feel will augment the information received from the usual positions.

The more or less accepted positions have been frequently described and discussed and will only be briefly noted here. The first exposure is made with the patient sitting upright, the occiput against the Potter-Bucky diaphragm, and the chin tipped slightly downward, with the central ray directed through the head just above the frontal sinuses. This is the so-called anteroposterior position. The patient is then turned around, and the side of the face is placed against the Potter-Bucky diaphragm, care being taken to place the anteroposterior plane of the head parallel to the Potter-Bucky diaphragm. In this position stereoscopic films are made. Similar exposures are then made on the opposite side. After this the patient is turned so that the nose and forehead are against the Potter-Bucky diaphragm with the ray directed through the head in the long axis of the lateral ventricles—the so-called posteroanterior position.

In the new position to which we partic-

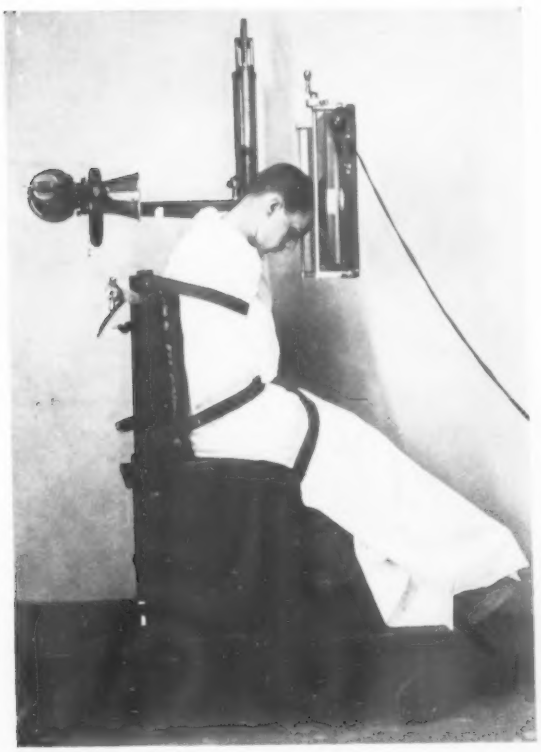


FIG. 1. Patient in chair with head in correct position with reference to Potter-Bucky diaphragm and roentgen tube.

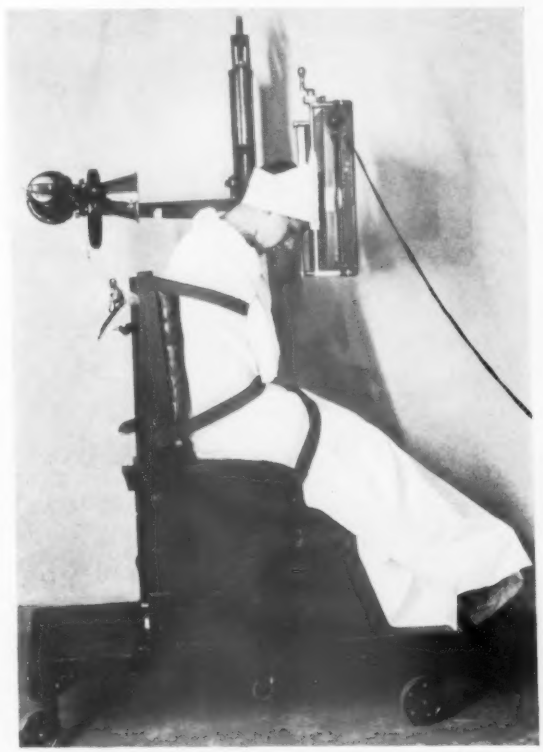


FIG. 2. Another view of the same position with head band in place.

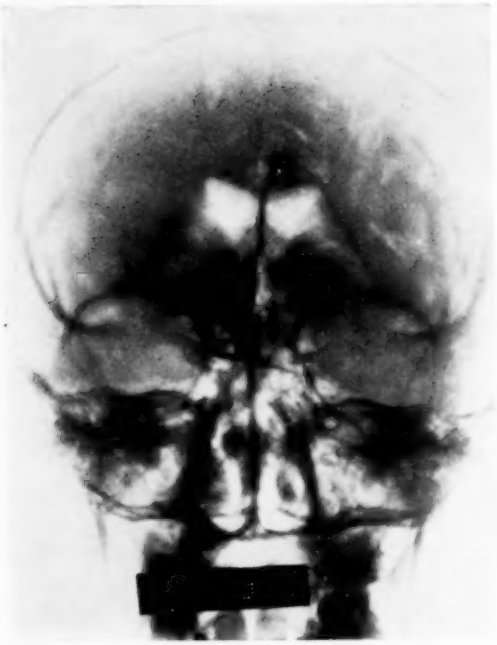


Fig. 3. Illustration of an anteroposterior film taken in the usual position.

Fig. 4. Illustration of a posteroanterior film taken in the usual position, same patient.

ularly wish to call attention, the patient is placed facing the Potter-Bucky diaphragm, the head being flexed as completely as possible on the chest. The vertex of the skull is placed against the Potter-Bucky diaphragm and the central ray directed through the skull in such a manner as to pass just above the lower cervical vertebra. One must be extremely careful to have the patient exactly in the proper position and the

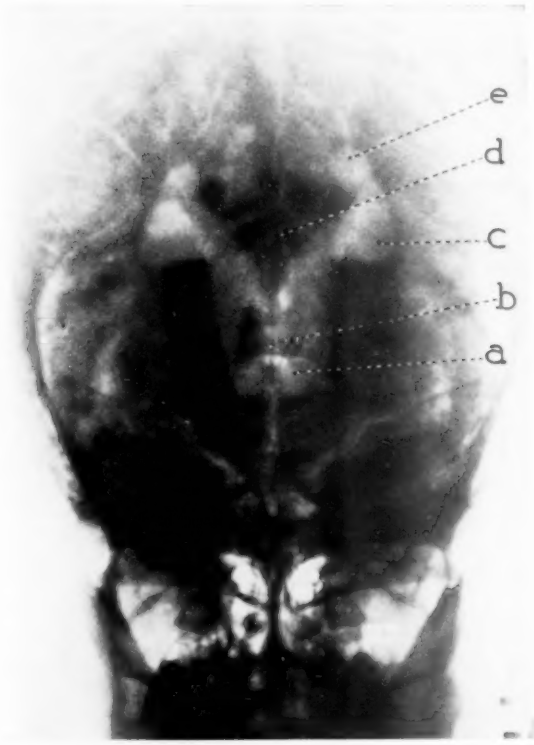


Fig. 5. Illustration of film taken in the new position, same patient. a. Anterior horn of lateral ventricle. b. Third ventricle. c. Body of lateral ventricle at the junction of the body with inferior horn. d. Fourth ventricle. Fourth ventricle is somewhat indistinct in the reproduction. It is much clearer in the original plate. e. Posterior horn of lateral ventricle.

central ray properly directed, otherwise the resultant film is of little value. The position in effect is an exaggeration of the posteroanterior position. When properly carried out, one visualizes on the roentgeno-

gram the lateral ventricles in their long axis, the third and fourth ventricles, and occasionally the aqueduct of Sylvius. The posterior horns of the lateral ventricles appear nearest the vertex of the skull with the fourth ventricle between them. The anterior horns and third ventricle appear considerably below the posterior horns, and, of course, farther forward.

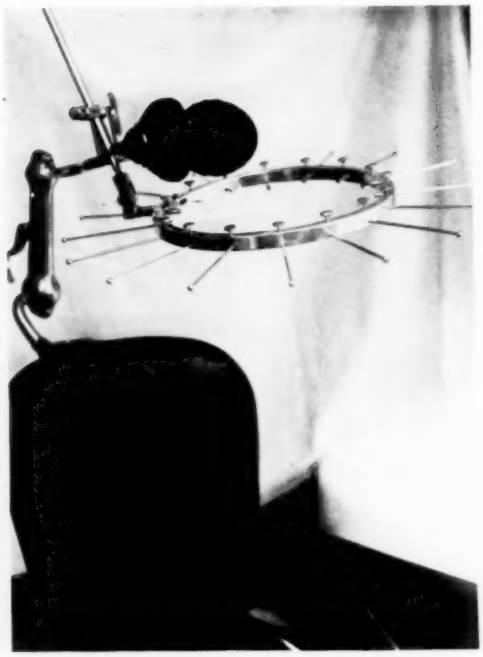
The patient is placed next in the horizontal position with the head lying on the Potter-Bucky diaphragm so as to make a lateral view, and with the vertex of the head slightly below the level of the chin. A similar film is taken of the opposite side allowing five or six minutes after the change of position before the exposure is made. In this position the inferior horns of the lateral ventricles appear well outlined.

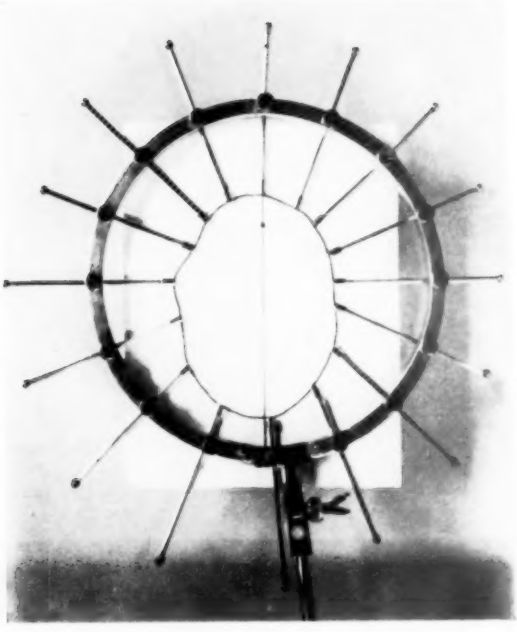
Lastly, encephalograms are made in some of the ventriculogram positions. With the patient horizontal and the face down, posteroanterior and lateral films are made. The patient is then turned and with the occiput down, anteroposterior and lateral films are made. In these films the anterior, posterior and inferior horns of the lateral ventricles, particularly the third and fourth ventricles, are well visualized. The films taken in the ventriculogram positions serve as a check on those taken with the patient upright. Occasionally we have noted in the upright position an apparent ventricular defect, although films made on the same patient at the same time in the ventriculogram position show what appear to be normal ventricles.

Although at the present time we find some difficulty in the interpretation of films made in the new position, still we feel that it enables us to obtain more complete knowledge of the form of the ventricular system.

A DEVICE FOR MEASURING DIAMETERS AND THE CONTOURS OF CROSS-SECTIONS OF THE HEAD AND NECK

By HAYES E. MARTIN, M.D.
Memorial Hospital
NEW YORK CITY





THE device described here has been found useful in obtaining diagrams of the contours and in quickly measuring all diameters of cross-sections of the head and neck. Correct measurements of this nature are essential to the determination of tissue dosage in radiation therapy.

It consists of two metal half rings joined by a hinge so that the complete ring may be opened and closed to surround the neck or head at any level. Arranged in a radial manner at regular intervals about the ring are sixteen sliding rods, which record the outline of the part surrounded by contact of their inner ends with the skin surface. The entire device is hinged to a larger metal rod for attachment to the head-rest of an examining chair. The sliding rods may be fixed in position by set screws after adjustment, so that their inner ends just touch the skin surface. The ring is then opened, removed, and placed flat on a sheet of paper. A line drawn through and joining the inner ends of the radial rods gives a true cross-section diagram. The position of any node or focus of disease may be quite accurately localized in the diagram, if its position in relation to one or more of the contact points be noted during the adjustment.

This apparatus has been constructed by Mr. A. Schreiner, master mechanic of the Memorial Hospital machine shop.

BOOK REVIEWS

Books Received Are Acknowledged under Heading: Books Received. This must be regarded as a sufficient return for the courtesy of the sender. Selections will be made for review in the interests of our readers as space permits.

The Chest. (Annals of Roentgenology. Vol. XI. Edited by James T. Case, M.D.) By L. R. Sante, M.D., F.A.C.P. Cloth. Price, $20.00. Pp. 561, with 246 illustrations. New York: Paul B. Hoeber, Inc., 1930.

"The Chest" has already been widely reviewed and should have been read by all who are interested in chest work. For the benefit of the few who may have neglected to do this a brief comment is in order.

A preliminary examination of the table of contents shows the very inclusive nature of the book, suggesting its value for reference. Not until it is carefully read can one comprehend the wealth of information abounding therein nor appreciate the pleasing style which holds the reader's interest and makes him oblivious of the passing time.

For the novice in chest roentgenography the practical observations on technique will be valuable. A thorough knowledge of a few positions is advised rather than a smattering of many special methods. The wisdom in discounting the advisability of stereoscopic films as a routine measure may be questioned by some inasmuch as it may provide an excuse for inaccurate work on the part of those unable or unwilling to discriminate as does the author. We are inclined to agree with him in his firm stand against routine roentgenoscopy, it being a rather barren source of information in average cases, and unnecessarily increasing the amount of exposure to radiation.

Serial roentgenography, the repeated study of the chest to note pathologic evolution, receives its just share of emphasis as does also the need for the roentgenologist to have a proper clinical history at his disposal. In reading of films he recommends following an outline in order to be sure of all-inclusive observation and it is evident from the text that Dr. Sante has studied his cases in a logical manner. Reading his comments should inspire one to a similar logical consideration of material under study. Those inclined to disagree with him should be very sure of their grounds, his statements being based on careful analysis of an immense quantity of material.

The author touches rather briefly upon the thymus gland, which forms a considerable part of the work of many roentgenologists. We realize that this question is voluminously discussed by others, yet we feel that a more detailed consideration of this subject would have added to the value of the work and we hope his next revision may include more of his personal conclusions about it.

Many of us get into the habit of accepting every day findings in a disinterested way. Pneumonia is simply "a pneumonic process" in our reports, but after reading Sante's observations on the different types of pneumonias we have an entirely different conception and our illusions regarding the simplicity of the subject vanish. And yet no subject is handled in an obscure or involved manner. Etiology, pathology, course, prognosis, roentgenologic (often clinical) findings and differential diagnosis are treated in logical sequence. Especially practical is the differential diagnosis which is given a very prominent place. For example, hilum pneumonia is differentiated from thirteen other conditions, each being considered separately and in detail. Sante has not sacrificed clearness for the sake of brevity and differential diagnostic points are often repeated under the various diseases.

The book is large, well printed, profusely illustrated and therefore necessarily somewhat expensive. However, more correctly diagnosed cases resulting from its study should provide compensation in greater satisfaction which comes from work well done.

E. W. Hall

Physics of Radiology. For the Student of Roentgenology and Radium Therapy. By J. L. Weatherwax, M.A., Physicist, Philadelphia General Hospital, Associate in Radiotherapeutic Physics, University of Pennsylvania Graduate School of Medicine. With a foreword by Henry K. Pancoast, M.D., Professor of Roentgenology. University of Pennsylvania. Cloth. Price $5.00. Pp. 240, with 126 illustrations. New York: Paul B. Hoeber, Inc., 1931.

This book provides probably the most mod-

ern discussion of the subject and moreover condenses it into nearly handbook form without sacrifice to its clearness. Its writing is based largely on the extensive clinical experience of the author as a physicist in hospitals and hence sight of the medical problem is not lost in a maze of physics. In the first two chapters is given a brief outline of the parts of electricity and atomic theory necessary for an understanding of the remainder of the book. The parts on radium and X-rays are for the most part given over to exceedingly practical discussions of measurements and their application to treatment. In perhaps no other phase is the radiologist more at sea, and I believe that in these chapters he will find answers to many of his questions. The discussion of the biological effects of X-rays is more nearly a discussion of dosage technique for different treatments with particular reference to the "saturation loss" methods used extensively in the Philadelphia hospitals. In carrying his whole development of the subject to a logical close he gives complete dosage technique for some specific cases, showing all of the necessary charting to determine the ports of entry and dose through each, and finally the dosage charts for the divided close technique, giving corrections for the "saturation loss." It is to be regretted that more complete references were not given to enable the reader to more readily refer to the original articles. The importance of the material in the book indeed justifies its writing.

Lauriston S. Taylor

Practical Radiation Therapy. By Ira I. Kaplan, B.S., M.D., Director, Division of Cancer, Department of Hospitals, New York City; Attending Radiation Therapist, Bellevue Hospital. With a special chapter on Applied X-ray Physics, By Carl Braestrup, B.Sc., P.E., Radiation Physicist, Division of Cancer, Department of Hospitals; Physicist to Mt. Sinai Hospital, New York City. Cloth. Price, $6.00. Pp. 354, with 227 illustrations. Philadelphia: W. B. Saunders Co., 1931.

This book, as the title signifies, is a very practical text. It concerns itself only with the actual details of radiation therapy as it is carried out at Bellevue Hospital where some 2,000 cases are treated each year.

The first 97 pages are devoted to the preparation of radium and roentgen apparatus and roentgen and radium physics. Methods of calculating dosage of roentgen rays and radium are briefly described. Short but very valuable chapters deal with endothermy and the nursing care of patients with malignant conditions. The relation of the nurse to the cancer patient has never been sufficiently stressed and every school of nursing could profit by the information set down by Dr. Kaplan. The dermatological aspects of radiation therapy are covered in approximately 30 pages and the remainder of the book details the techniques used in the treatment of the many other conditions which are benefited by roentgen rays and radium. The sections on cancer of the skin, mouth and uterus are particularly good. The treatment of cancer of the breast with multiple heavily filtered radium needles as recommended by Geoffrey Keynes is described and several cases receiving treatment with a modification of this very promising new method are cited. Many photographs and sketches enhance the value of the descriptive matter which is concise and detailed and lacks the fault of omission so frequently found in articles dealing with technique. It is interesting to note that in most instances endothermy and radium are given precedence over roentgen radiation in the treatment of malignant tumors.

The radium technique is, for the most part, that used by Regaud at the Radium Institute in Paris. Tumors are treated with multiple containers having platinum walls 0.5 to 1.5 mm. thick and filled with very small amounts of radium element. The time of application is lengthy, often requiring from three to seven days, and the applicators are made up in the form of needles, capsules and external molds that fit over the surfaces of the body. Deep roentgen therapy is applied in accordance with Holfelder's cross-firing plan but the doses are divided as suggested by Solomon.

It seems unfortunate that this rather brief treatise could not have been enlarged to include more data relative to prognosis, complications, changes observed during treatment and end-results. The absence of references to the literature and a more comprehensive bibliography are noticeable but since the book is merely intended to cover the procedure in one institution this is not a serious defect. The radiotherapist who is interested in the more recent methods will find it a most useful handbook.

Charles L. Martin

RÖNTGENTHERAPEUTISCHES HILFSBUCH. FÜR DIE SPEZIALISTEN DER ÜBRIGEN FÄCHER UND DIE PRAKTISCHEN ÄRZTE. Von Dr. Robert Lenk, Dozent für medizinische Röntgenologie an der Universität Wien. Mit einem Vorwort von Professor Dr. Guido Holzknecht. Fourth edition. Paper. Price RM, 4.80. Pp. 85. Wein: Julius Springer, 1930.

This little book, with a foreword by G. Holzknecht, is written for the general practitioner and those specializing in branches other than roentgenology. It intends to furnish sufficient data to guide the physician in referring the proper cases to the roentgenologist. In the first fifteen pages, the mechanism of the effect of roentgen rays, the prognosis, reaction during and following treatment and supplementary therapy are briefly outlined. Then follows the special part with an alphabetical index of 164 diseases amenable to roentgen rays. The arrangement may be illustrated by the following quotation selected at random: *Angina pectoris*. The treatment is only symptomatic; it is indicated particularly if internal medication does not relieve the attacks of pain. The pathologic process itself, for instance, aortitis, coronary sclerosis, is not influenced by irradiation. Mechanism of effect: still unknown; treatment based on practical experience. Prognosis: (*a*) result of the treatment: frequently considerable relief or even complete disappearance of the pain, sometimes for many months; (*b*) duration of treatment: a few hours following the treatment, the attacks cease; sometimes repetition of the treatment in four to six weeks necessary; if attacks recur, more treatment; (*c*) course: (see under (*b*). Symptoms accompanying and following irradiation: none. Principal treatment: the usual medical therapy; very often antiluetic treatment. Contraindications: none. Treatment formula:

$$1\text{–}2 f_{aa} 150 \begin{cases} \uparrow 30 \longrightarrow 180 \\ \mid P_1(2\text{–}3)0.5z^{P}4\text{–}6)1\text{–}2. \end{cases}$$

Effective dose in the heart: about 25 per cent H.E.D. Field: left thorax, sometimes left dorsal region.

The formula, which represents a code system explained in detail in the first part, gives the essential technical factors, e.g., number of exposures, skin areas, dose in H units, filter, focus skin distance, and tube potential. For deep therapy radiation (180 kv., copper filter) 1 H.E.D. is equal to 12 H, corresponding to 720 r. For radiation of lower potentials and less filtration, this is reduced to as low as 40 r for 1 H. One must be familiar, therefore, with the code before attempting an interpretation of the therapeutic data. The book appears now in the fourth edition and has been translated in many foreign languages; an English edition is also available.

ERNST A. POHLE

INDEX TO ABSTRACTS

ROENTGEN DIAGNOSIS

Head

Goldstein, Leopold: Radiogenic microcephaly; a survey of nineteen recorded cases, with special reference to ophthalmic defects 543

Vincent, Cl., and Stuhl, L.: Neuro-epithelioma of the retina and chiasm in a child aged five 543

Neck and Chest

Pondé, Adriano, and Silveira, José: Concerning several cases of azygos lobe 543

Perlstein, Robert N.: A case of fibrinous bronchitis complicated by massive atelectasis 543

Morison, J. W. Woodburn: Massive collapse of the lung (active lobar collapse) 544

Darbois and Duval: The etiologic mechanism of left-sided eventrations 544

Labbé, Marcel; Soulié, and Stuhl, L.: Diaphragmatic eventration secondary to spontaneous pneumothorax 544

Stein, Jacob: Congenital pneumothorax 545

Abdomen

Pop, Alexandru, and Spârchez, Tiberiu: Contribution to the study of gastric tuberculosis on the basis of four personal cases 545

Case, James T.: Fundamentals in roentgenology of the colon 545

Barker, Lewellys F.: Polyposis of the colon 548

Gutmann, R.-A., and Nemours Auguste: Concerning new techniques of roentgen examination 548

Surmont, H., Surmont, J., and Tiprez, J.: Technique of stereoroentgenography of the colon by the ascending route 548

Ledoux-Lebard, R.: The visibility of the normal gall-bladder 549

Gynecology and Obstetrics

Jameson, Edwin M.: Tuberculosis of the female pelvis 549

Béclère, Claude: Technique of hysterosalpingography 549

Genitourinary System

Thompson, Theodore: Addison's disease; the value of radiography in direct diagnosis .. 550

Skeletal System

Joseph, Benjamin M.: Osteitis fibrosa cystica, generalized type, with giant cell sarcoma 550

Gălăău, D.: Osteochondritis dissecans 550

Bittencourt, Januario: A case of rhizomelic spondylosis 551

Schneider, Chester C.: Double isolated compression fracture of the spine 551

Cone, Sydney M.: Syphilis of bone 552

Mayer, Leo, and Sashin, David: Report of a case of supernumerary foot 552

Mitchell, Joseph I.: Dislocation of the knee 552

Lapidus, Paul W.: Epiphyseal separation of the lesser femoral trochanter 553

Kreuscher, Philip H., and Hueper, W. C.: The histology of the postoperative healing process in chronic osteomyelitis and its prognostication from biopsy sections 553

Haret, Colaneri and Roederer: Radiotherapy of the thyroid gland and fracture of the neck of the femur 554

Sigurdson, Larus Arthur: The structure and function of articular synovial membranes 554

Wagner, Lewis Clark: Intraarticular endothelial tumors arising from synovial membrane 555

Geschickter, Charles F., and Copeland, Murray M.: Recurrent and so-called metastatic giant cell tumor 555

Blood and Lymph System

Dyes, Otto: Anemia, age of cells and radiosensitiveness 557

General

Mason, James B.: Desmoid tumors 557

ROENTGEN AND RADIUM THERAPY

Simons, Albert: Treatment of keloids and hypertrophied scars 558

Hoede, Karl: Roentgen injury after epilation by means of irradiation in hypertrichosis 558

Delherm and Laquerrière: Radiotherapy of painful perivisceritis 558

Fuhs, Herbert and Konrad, Josef: General treatment of skin diseases with Bucky's borderline rays 558

Ward, Roy: Radium treatment of epitheliomata of the skin 559

Backmund, Karlheinz: Further experience with the roentgen treatment of brain tumors 559

Astier, André: Results and indications of radiotherapy in exophthalmic goiter 560

Dévé, F., and Lessertisseur: The present inefficiency of penetrating radiotherapy and diathermy in hydatid cyst 560

Schulte, G.: Roentgen treatment of diseases of the tonsils ... 560
Cade, Stanford: Radium treatment of cancer of the tongue ... 561
Adair, Frank E.: The response of various types of breast cancer to radiation ... 562
Seisser, F.: Present-day questions in gynecological radiotherapy ... 562
Forsdike, Sidney: Radium in gynaecology ... 564
Healy, W. P.: Variation in radiosensitivity of epidermoid carcinoma of the cervix uteri 564
Bowing, Harry H.: The immediate response observed in the treatment of cases of carcinoma of the cervix uteri with radium ... 565
Dautwitz, Fritz: Does indirect radium irradiation cause late injury of the fetus? ... 566
Martius, Heinrich: Roentgen rays and injury of the embryo ... 566
Duncker, Hans: Roentgen rays and injury of the embryo ... 567
Knuthsen, L. F. R., and Humphris, F. Howard: Pruritus ani et vulvae ... 567
Schreiner, Bernard F.: Treatment of epithelioma of the penis based on a study of sixty cases ... 567
Brummer, K.: A case of the same effect produced by ultraviolet and roentgen rays ... 568
Cremer, Max: Roentgen cataract and its prevention ... 568
Martin, Hayes E.: Factors in dosage determination in interstitial radiation ... 568
Coutard, H.: Principles of roentgen therapeutic technique in deep cancer ... 569
Miescher, G.: Present methods of cancer treatment and their results. I. The single large dose ... 569
Schinz, Hans R.: Present methods of cancer treatment and their results. II. Divided dose ... 570
Fitzwilliams, Duncan C. L.: The technique of radium therapy to-day ... 571
Souttar, H. S.: The use of radon seeds in the treatment of carcinoma ... 571
Russ, S., and Clephan, Dorothy F.: Distribution of radiation from clinical radium tubes ... 571
Carling, Francis Rock: Latest modification of Westminster teletherapy apparatus ... 571

MISCELLANEOUS

Fling, H. T., and Grimmett, L. G.: Measurement of the distribution of gamma rays around a four-gram mass of radium ... 572
Cairns, Hugh and Fulton, J. F.: Experimental observations on the action of radon on the spinal cord ... 572
Heim de Balsac, F., Agasse-Lafont, E., and Feil, A.: Preparation and manipulation of radioactive bodies; professional pathological risks, prophylactic measures and results ... 572
D'Halluin, Maurice: Cancer, experimental glycemia, radiations ... 573
Piffault and Barreau: Radiations. On the subject of cancer; experimental glycemia; radiations ... 573
Belot, J.: Coolidge tube functioning at 400,000 volts constant tension ... 573
Solomon: Apparatus for ionometric control ... 574
Surmont, H., Surmont, J., and Tiprez, J.: Presentation of an apparatus permitting horizontal stereoroentgenography ... 574
Goldstein, M. J., and Neworoschkin, J. P.: Changes in the catalase and lipase content of the blood of patients treated with roentgen rays ... 574
Johnson, Clayton R.: Stereoroentgenometry; a method for mensuration by means of the roentgen ray ... 575
Schinz, Hans R.: Hospital and roentgen laboratory ... 575
Markl, J.: Emanation therapy and physiological dosage ... 575
Russo, C.: The significance of inductive precision regulation and distant control of the roentgen apparatus ... 575
Adler, Karl: The biological effect of short wave radiation upon the metabolism of the cell ... 576
Murphy, Douglas P., and de Renyi, Marguerite: Postconception pelvic irradiation of the albino rat; its effect upon the offspring ... 576
Markl, J.: The theoretical foundations of internal radium therapy, emanation therapy and biological dosage ... 576
Piccard, A., and Stahel, E.: The significance of the secondary beta rays in problems of gamma-ray therapy ... 576

ABSTRACTS OF ROENTGEN AND RADIUM LITERATURE

ROENTGEN DIAGNOSIS

HEAD

Goldstein, Leopold. Radiogenic microcephaly; a survey of nineteen recorded cases, with special reference to ophthalmic defects. *Arch. Neurol. & Psychiat.*, July, 1930, *24*, 102–115.

In a previous communication, Goldstein and Murphy stated that pelvic radiotherapy during pregnancy is extremely injurious to the fetus. Thus of 75 children so exposed, 20 exhibited marked defects, 18 being microcephalic defects. Heredity, syphilis, general health of mother prior to and during pregnancy, and circumstances incident to labor were possibly responsible for the ill health of 38 children irradiated in utero. Sixteen cases of microcephaly were attributed only to fetal irradiation. In 2 cases there seemed to be some evidence that parental influences had played a rôle; in one, the mother was tuberculous, and the father was a victim of alcoholism, in another the mother had borne a child who had spasms, prior to receiving any irradiation. They concluded that irradiation during pregnancy frequently inhibits the development of the central nervous system.

Disturbances of the eye were frequently observed, and the authors coined the words, describing these defects as being associated with "radiogenic microcephaly." The first case was reported by Aschenheim in 1920. Since that time many cases have been reported.

A table is given detailing the type of treatment that was received by the 19 patients, 15 of these receiving radiotherapy during the first four months of gestation, 4 in the fifth month.

Another table is given describing the characteristics of the 19 microcephalic children including the weight at birth, 13 being underweight. Fifteen were born at term, 4 prematurely, 9 infants had small round heads, 3 had oxycephaly. Ocular defects were evident in 15. Another table details the ocular defects in relation to the malformation of the head.

The author believes that irradiation acts somewhat similarly to toxic factors or environmental influences in arresting fetal development. The nervous system is readily affected by any external factor. The development begins early (second week) and is particularly susceptible at this time. Experimental evidence tends to prove the high degree of radiosensibility of the nervous system.

The authors compared the ocular defects of the "radiogenic microcephaly" with the defects found in non-radiogenic microcephaly and they found the defects to be more frequent and severe in the radiogenic.—*E. P. Pendergrass.*

Vincent, Cl., and Stuhl, L. Neuro-épithéliome de la retine et du chiasma chez un enfant de cinq ans. (Neuro-epithelioma of the retina and chiasm in a child aged five.) *Bull. et mém. Soc. de radiol. méd. de France*, July, 1930, *18*, 296–297.

A case of neuro-epithelioma of the chiasm which spread to the retina of the right and later of the left eye and in which roentgen therapy led to a remarkable temporary improvement is described in detail. The good response to irradiation is explained by the fact that the tumor was very cellular and the cells very poorly differentiated.—*T. Leucutia.*

NECK AND CHEST

Pondé, Adriano, and Silveira, José. A propos de plusieurs cas de lobe de la veine azygos. (Concerning several cases of azygos lobe.) *Rev. sud-am. de méd. et de chir.*, June, 1930, *1*, 545–555.

In 1929 the authors published a case of azygos lobe in the *Jornal dos Clinicos*. Since then they have had the opportunity to observe another case. This is described and discussed in lengthy detail. The two cases occurred in a total of 1700 personal films.

The authors also include a case showing a peculiar triangular shadow at the right apex similar to that described by Bársony and Koppenstein. Although no definite stand is taken with regard to the significance of this shadow, the opinion is expressed that it most probably represents an accessory lobulation of the right lung.—*T. Leucutia.*

Perlstein, Robert N. A case of fibrinous bronchitis complicated by massive atelectasis. *Am. Rev. Tuberc.*, July, 1930, *22*, 82–86.

The author reports a case of massive atelectasis caused by a fibrinous cast of the bronchus. Fibrinous bronchitis is a rare condition, only 176 cases having been recorded in the literature. The cause of this peculiar type of condition is uncertain; Engel says that it is a metabolic disturbance of the bronchial mucous membrane. The author presents two illustrations of the roentgenograns, demonstrating the roentgen findings of massive atelectasis. —*E. P. Pendergrass.*

Morison, J. M. Woodburn. Massive collapse of the lung (active lobar collapse). *Brit. M. J.*, Aug. 16, 1930, *2*, 237–242.

Active collapse of a lobe or part of a lobe must be distinguished from the passive collapse seen in effusion, pneumothorax, or bronchial occlusion due to growth. In the former there is an acute onset usually preceded by fever. Eight cases of this type are reported which indicate that the condition is found in postoperative and post-traumatic cases of all ages as well as in pneumonia in children and young adults.

The most commonly accepted theories as to the cause of active lobar collapse are: 1. The failure of respiratory power. 2. The mucus plug theory. 3. Reflex spasm of bronchial muscles. 4. Inflammation of the crus and half of the diaphragm or the pleural membrane covering it. Any theory to be sustained must account for: 1. The accumulation of mucus in the bronchial tubes. 2. The rise of temperature preceding collapse, or no rise in temperature. 3. The sudden onset of symptoms. 4. The varying time after operation or injury of the sudden onset. 5. The occurrence of cases apart from anesthetics, operations or injury. 6. The occurrence of cases as complications of inflammatory diseases of the lungs. 7. The contralateral cases. 8. The bilateral cases.

The primary cause is probably a reflex disturbance of the sympathetic and vagus innervation of the lungs, resulting first in a dilatation of the bronchi with cessation of the wave-like movement and a consequent accumulation of mucus. This is due to overactivity of the sympathetic, and it is at this stage that the slight rise of temperature so often occurs. Return of balance may clear up the condition. Overaction of the vagus, on the other hand, may cause spasm, aggravating the condition.—*G. R. Miller.*

Darbois and Duval. Note sur le mécanisme étiologique des éventrations diaphragmatiques gauches. (The etiologic mechanism of left-sided eventrations.) *Bull. et mém. Soc. de radiol. méd. de France*, July, 1930, *18*, 289–292.

The authors had the opportunity to study the mechanism of a left-sided diaphragmatic eventration in a patient treated with pneumothorax for apical tuberculosis. It was observed that the collapse therapy resulted in an abnormal lowering of the diaphragm dome on the left side due no doubt to a paresis of the muscles of the diaphragm. In order to verify the paresis the authors insufflated, by a special cannula, air into the splenic angle of the colon, at the same time aspirating air from the pneumothorax by means of a trocar. As soon as the pressure in the colon increased and the intrathoracic pressure decreased, an upward displacement of the dome of the diaphragm followed. From this the conclusion was drawn that the eventration of the diaphragm is conditioned by the paresis of the diaphragmatic muscles. In such a person a simple attack of aerocoly would be sufficient to provoke all the symptoms of an eventration. In 3 cases which the authors observed recently the sudden appearance of eventration which was accompanied by pain, dyspnea, anxiety, etc., was the result of rather mild gastric disturbance.

The conclusion is reached that the left-sided diaphragmatic eventration, appearing suddenly and without apparent cause, is the result of a diaphragmatic paresis, due to various causes, such as pleurisy, spontaneous pneumothorax, collapse therapy, phrenicectomy, etc.—*T. Leucutia.*

Labbé, Marcel; Soulié, and Stuhl, L. Éventration diaphragmatique consécutive à un pneumothorax spontané. (Diaphragmatic eventration secondary to spontaneous pneumothorax.) *Bull. et mém. Soc. de radiol. méd. de France*, July, 1930, *18*, 292–295.

The authors describe in detail a case of left-sided diaphragmatic eventration which occurred in a man thirty-seven years of age, as a result of spontaneous pneumothorax.

Roentgenologically there was a marked upward displacement of the diaphragmatic dome with a reversed U-shaped stomach, which after administration of the barium meal showed a typical picture of a cascade stomach. The

mobility of the diaphragm was preserved and there was absence of Kienböck's sign.

Diaphragmatic eventration is not rare. This case, however, is of particular interest since there was association of a spontaneous pneumothorax and diaphragmatic eventration on the same side.—*T. Leucutia.*

Stein, Jacob. Congenital pneumothorax. *Am. J. Dis. Child.*, July, 1930, *40*, 89–95.

Stein reports a case of congenital pneumothorax. His case, a boy, one week old showed a pneumothorax involving the entire right side of the chest. At the time he reports the case the child is two years old, is physically small for his age, has a pigeon breast deformity, has had several attacks of bronchitis in the left lung without any undue consequences, and at no time has suffered from dyspnea or cyanosis. Roentgenoscopy has been performed many times during his two years of life with no change in the picture of the chest. At no time has there been any apparent absorption of the air. Possible etiologic factors have not become evident.

A thorough review of the literature disclosed only 4 cases previously reported. One case before the days of the roentgen ray, was diagnosed only at autopsy, in the other three, the diagnosis was suggested on physical examination and later was confirmed by roentgen examination. Treatment was attempted in only one case in which air was withdrawn from the chest on two occasions, the lung collapsing after the first aspiration. After the second aspiration, the lung was expanded except for a small area; the heart was in practically normal position and the general condition was "satisfactory." In Stein's case surgical treatment was considered but was not attempted.—*R. S. Bromer.*

ABDOMEN

Pop, Alexandru, and Spârchez, Tiberiu. Contribuţiuni la studiul tuberculozei gastrice in legătură cu patru cazuri personale. (Contribution to the study of gastric tuberculosis on the basis of four personal cases.) *Cluj. med.*, Sept., 1930, *11*, 433–439.

In a series of 1035 gastric operations at the surgical clinic of the University of Cluj the author found 4 cases of primary tuberculosis of the stomach. The 4 cases are described and discussed in lengthy detail.

With regard to the value of the roentgen examination, the opinion is expressed that there are no characteristic signs. In every instance there was evidence of a marked pyloric stenosis with considerable gastric residue which was thought to be the result of a benign gastric ulcer. In 2 cases the palpation of enlarged mesenteric lymph nodes at the time of the roentgenoscopic examination with the somewhat unusual appearance of the pyloric stenosis suggested the possibility of tuberculosis. The correct diagnosis, however, could be made only from the histopathologic findings at the time of the operation.—*T. Leucutia.*

Case, James T. Fundamentals in roentgenology of the colon. *Am. J. Surg.*, 1930, *8*, 844–858.

This article is the first of a series of papers by the author on roentgenology of the colon and deals with the normal anatomy and physiology as observed by the opaque meal and barium enema.

For convenience and anatomical reasons he divides the large intestine into: (*a*) the cecum, that portion of the large bowel proximal to the ileo-colic junction; (*b*) the ascending colon from the ileo-colic junction to the hepatic flexure; (*c*) the transverse colon, from the hepatic flexure to the splenic flexure; (*d*) the descending colon, from the splenic flexure to the level of the crest of the ilium, (*e*) the iliac colon, from the left iliac crest to the left ileopectineal line; (*f*) the pelvic colon, from the ileopectineal line to the rectal ampulla opposite the third sacral segment. The junction between the iliac and pelvic colon may be termed the iliopelvic junction, and that between the pelvic colon and the rectum the pelvirectal junction. The term sigmoid which includes both the iliac and pelvic colon does not have a place in the more convenient terminology given above.

Roentgenologically the large intestine is distinguishable from the small both by its large size and by the characteristic haustral sacculations which occur through the large bowel with the possible exceptions of the lower pelvic colon and rectum. The colon represents about one-fifth of the whole extent of the intestinal tract, averaging 4½ to 5 feet in length and the caliber varies considerably according to whether it is visualized by an opaque meal or by a barium enema. In the latter condition it is usually larger and more distorted. Because of this variance in size and in distortion the author recommends both the opaque meal and the barium

enema to properly study colonic function, for with the latter, haustral markings are nearly always absent and with the opaque meal they are always present, except during the execution of the mass movements which constitute the principal propulsive activities of the colon.

The average colon in health, described with the patient standing is as follows: the lower border of the cecum reaches as low as the right ileopectineal line, the hepatic flexure extends upwards as far as the costal margin and the splenic flexure reaches as high as the lower border of the spleen. The level of the lower border of the transverse colon varies considerably with different patients. In short, stocky, obese individuals the transverse colon is usually high, the lowest point approaching a line joining the iliac crests; whereas in tall, thin individuals it tends to be V-shaped or U-shaped and extends several inches below a line joining the iliac crests.

The colon should be freely movable throughout all points unless bound down by adhesions or operative fixation, though normally the iliopelvic junction may appear to be immobile due to the short mesocolon at this point. In heavy patients it may not always be possible to test the mobility of the colon with manipulation but in these cases, accurate deductions can be drawn by a comparison of the height reached by the pelvic loop during the filling of the colon by enema with that reached by it, following visualization by an opaque meal.

The position of various segments of the colon varies considerably. Four hours after an opaque meal the cecum can be separated from the terminal ileum in the right lower quadrant. The appendix may also be seen at this time. The cecum has a rounded form and is usually mobile in all directions. The shape and position varies in different individuals, from the high cecum in congenital shortening of the ascending colon to the cecum mobile which is frequently found in the true pelvis. Incomplete rotation of the colon presenting an inverted cecum is among the other aberrations from the usual arrangement.

The hepatic flexure varies considerably in length, shape and position. The ascending colon may merge directly into the transverse, in others there may be formed a loop of varying patterns.

In the transverse colon one may see a variety of positions, not only in comparing one patient with another but also in the same patient at different times. It may vary from an almost straight W or a V to a stirrup form or an inverted U. All of these changes are possible because of the long transverse mesocolon.

The splenic flexure is more nearly fixed than any other part of the colon and forms what in the roentgenogram of the abdomen often looks like an acute angulation. Lateral roentgenoscopy shows plainly with rare exceptions that this flexure forms a rather generous curve from the anteriorly situated transverse colon with the posteriorly situated upper part of the descending colon.

The descending and iliac portions are usually short and straight, often empty and contracted. The descending colon is a conducting tube from the proximal colon into the lower iliopelvic colon and rectal ampulla, and therefore often empty.

The pelvic colon is extremely variable in regard to size and position. It may join the rectum from the left or right side or from above. It may be very short, often encountered in obese individuals, or it may be so long as to extend higher than the transverse colon.

The author recommends a routine technique be used in examining the colon modifying or extending the routine as the circumstances seem to demand. A study of the function of the bowel must be carried out in the functioning bowel and during this investigation the patient should follow as nearly as possible his ordinary schedule of meals and activities. When an organic lesion is suspected and the diagnostician wishes deliberately to overlook the functional aspects of the case, the usual routine may be dispensed with. The colon may be studied after air distention, after an opaque meal or after an opaque enema.

For gas distention air is pumped into the bowel through a rubber tube inserted an inch or two into the rectum and observed under the fluoroscopic screen. The practical diagnostic worth of this procedure is confined to the differentiation of certain tumors or foreign bodies or to set out more clearly the contours of some neighboring organ.

For the opaque meal any standard mixture with barium sulphate is acceptable. Following a meal the stomach should be empty within four and a half hours at which time the head of the column should have reached the cecum. The entire barium meal should have passed into the colon by the eighth or tenth hour, when the

head of the barium column should have reached at least as far as the middle of the transverse colon. The head of the barium should reach the iliac colon in from nine to sixteen hours and the colon should be completely emptied of the opaque material by the thirty-sixth to forty-eighth hour. Strict regularity in filling and emptying is not observed in the colon and it is difficult to fix any normal standard.

The appearance of the opaque meal in the colon is variegated. The haustra are most pronounced in the transverse colon but seen more or less throughout the large bowel. In the cecum the opaque masses form a cylindrical structure with a rounded bottom but varying greatly in pattern. At the splenic flexure and in the descending colon the boluses are more round and separated in a typical manner or crowded into conglomerate masses. In the sigmoid definite masses begin to appear in coherent sausage-like forms, and in the rectal ampulla one sees the characteristic symmetrically formed mass.

For the opaque enema most roentgenologists prefer some modification of the method of Haenisch. The Haenisch enema consists of bolus alba 300 gm., bismuth carbonate 75 gm., and water sufficient to make one liter.

The technique observed during the injection of the opaque enema is not complicated. A preliminary cleansing enema given two to three hours before the opaque enema is usually advisable. Some roentgenologists prefer a mild laxative, others use both methods of cleansing. An enema container with 6 or 7 feet of rubber tubing attached is suspended 2 or 3 feet above the horizontal roentgenoscopic table. At the middle of the tubing an ordinary bulb syringe is introduced to make sure that no air enters the colon. Hard rubber or metallic enema tips are attached to the tubing and inserted an inch or two into the rectum. It is not necessary to insert it farther to obtain the so-called high enema, for the above procedure will suffice. The flow of the opaque fluid is controlled by a clamp and the injection should be controlled by roentgenoscopic observation. Failure to do so may lead to serious error in interpretation. When the clamp is opened there first appears in the pelvis a pear-shaped shadow which gradually increases in size showing the filling of the ampulla. Following this the opaque fluid seeks an outlet into the pelvic colon. Whether or not we shall be able to see distinctly the pelvirectal junction depends upon the location and disposition of this portion of the large bowel. When it appears toward the left it is usually possible to distinguish the pelvirectal angle, especially if the patient be turned so that an oblique illumination can be employed. When it appears toward the right or midline the shadow of the opaque mass in the ampulla obscures the vision.

In almost every case there will appear to be a narrowing of the bowel where the pelvic colon passes the iliopectineal line at its junction with the iliac colon. The appearance of narrowing is often exaggerated by the very short mesocolon possessed by this segment of the large bowel, and especially by the adhesions which often exist at this point. There first appear in the van of the advancing column several small boluses showing the regular spacings due to the haustra coli but under the increasing pressure these are obliterated and the bowel shadow becomes broader, darker and more homogeneous. Normally the pelvic colon rises higher in the abdomen during the injection of the enema, owing to the increasing pressure and when this does not occur it may be taken as evidence strongly suggestive of adhesions.

The progress of the enema after reaching the descending colon is uninterrupted until it reaches the splenic flexure where there is a normal appearance of retardation. This is only apparent as can be shown by turning the patient in an oblique view and watching the filling of the loops at this point.

In the transverse colon there is often observed an apparent filling defect due to the saddling of the colon over the spinal column. This is especially noticed in cases of increased intra-abdominal pressure.

In the hepatic region the fluid is observed to follow a devious course, indicating a redundancy of the bowel, but very rarely is there any kinking even though adhesions are present. The fluid then passes down the descending colon, filling the cecum. When the ileocolic valve is competent the enema stops at the cecum; but in the rather large majority of cases in which the valve is found incompetent the terminal coils of the ileum are seen to fill.

Normally the opaque enema passes through the entire colon to the cecum without exciting any visible peristaltic actions; but in the conditions of inflammation or over-distention charac-

teristic ring contractions are seen. When seen these have diagnostic value.

The author recommends the taking of films when the pelvic loop has been filled and after the entire colon has been outlined. The use of small amounts of barium together with the injection of air and compression of the colon by a bulb balloon have been used to bring detail and contrast in visualizing earlier lesions of the colon and may be a better way than the usual irrigoscopic methods.—*F. K. Alexander.*

Barker, Lewellys F. Polyposis of the colon; discussion of the heredofamilial occurrence of the disease and of the extraordinarily favorable effects obtained in one case by deep x-ray therapy. *M. Clin. N. Am.*, July, 1930, *14*, 77–85.

Clinically intestinal polyposis may be symptomless, whereas other cases show abdominal pain, hemorrhages and recurrent diarrhea. Polyps may be found in the stomach, rarely in the small intestine and frequently in the colon. The proctoscopic picture of the rectal mucosa often is characteristic.

Polyps of the gastrointestinal tract are either pedunculated or sessile. They vary in size from that of a pea to a pigeon egg. True adenoma formation is present and there is a predilection for carcinomatous change. The etiology is uncertain, but there is probably a constitutional disposition released by local irritation. It has been shown that polyposis is a heredofamilial condition obeying the mendelian law.

Case I. A white male aged twenty-four died of intercurrent bronchopneumonia. He had complained of abdominal cramps, diarrhea and weakness of three days' duration. At autopsy extensive polyposis of the rectum and descending colon was found. The family tree showed a mendelian dominance of polyposis, these individuals all dying of carcinoma of the bowel.

Case II. A white male aged sixty-three with intermittent diarrhea, loss of 20 lb. and weakness, was diagnosed as having polyposis of the colon by roentgenogram. Deep roentgen therapy resulted in a symptomatic cure. Many polyps were passed as degenerated masses. Roentgenograms after treatment revealed evidence of only a few remaining polyps.

It is possible that roentgen therapy may prove valuable in treating this otherwise resistant and dangerous condition.—*G. R. Miller.*

Gutmann, R.-A., and Nemours Auguste. A propos de techniques nouvelles d'examen radiologique. (Concerning new techniques of roentgen examination.) *Bull. et mém. Soc. de radiol. méd. de France*, July, 1930, *18*, 303–305.

The authors present their method of procedure for the visualization of the folds of the intestinal mucosa. Thorium dioxide (Th_2O_2) which is known commercially as tordiol or umbrathor, is administered in the form of enemas (300 c.c. unbrathor in 600 c.c. lukewarm water). The patient is thoroughly prepared by preliminary purgatives and enemas. It is essential that at the examination the umbrathor be evenly distributed in the bowel, and therefore a slight massage of the abdomen is in order. The first roentgenogram is taken immediately after the injection of the enema, then the colon is evacuated by simply lowering the enema can so as to let the opaque liquid flow back, and a second roentgenogram is taken. Following complete evacuation of the bowel in the toilet, sometimes necessitating two or three trips, additional roentgenograms are taken.

The method is of value in the diagnosis of colitis, neoplasms, diverticulitis, and cancer of the recto-sigmoidal junction. The roentgen appearance of the folds of the mucous membrane and their diagnostic value in these conditions is briefly discussed.—*T. Leucutia.*

Surmont, H., Surmont, J., and Tiprez, J. Technique de l'examen stéréoradiographique des côlons par voie ascendante. (Technique of stereoroentgenography of the colon by the ascending route.) *Bull. et mém. Soc. de radiol. méd. de France*, July, 1930, *18*, 298–303.

The authors have constructed an apparatus for stereoroentgenography of the barium filled colon in the horizontal position.

The preparation of the patient as well as the technique of examination (barium enema) is described in detail. Based on an experience with 15 cases the authors arrive at the following conclusions with regard to the best position for the various segments of the colon: The hepatic flexure is best visualized in a vertical position, the transverse colon in both the vertical and horizontal positions, the splenic flexure, the descending and iliac colon in horizontal decubitus, and finally, the sigmoid in a sitting position, the patient being inclined at an angle of 45°. The dorsal decubitus is superior to the

ventral decubitus both from the point of view of the relief as well as of the definition of the roentgen images obtained in all colonic segments, except the midportion of the transverse colon.

In summarizing, the authors advise that in the routine practice roentgenograms following a barium enema be taken in dorsal decubitus, except in the cases of lesions of the transverse colon or ptosis when a ventral decubitus is indicated.—*T. Leucutia.*

Ledoux-Lebard, R. La visibilité de la vésicule biliaire normale. (The visibility of the normal gall-bladder.) *Bull. et mém. Soc. de radiol. méd. de France*, June, 1930, *18*, 243–244.

It was until recently the custom to consider all gall-bladder shadows showing on flat films (without preliminary preparation of the patient) as indicative of pathologic gall-bladders. The introduction of instantaneous exposures, the use of the Potter-Bucky diaphragm, the application of compression, the use of highly sensitive intensifying screens, etc., have considerably improved the technique of roentgenography so that now the visualization of the normal gall-bladder is not altogether rare. This is easily understood when one considers that the gall-bladder forms a sac containing from 20 to 40 c.c. of viscid fluid which under normal circumstances ought to cast a shadow. Therefore, the author warns against diagnosing gall-bladder shadows appearing on flat films as pathologic gall-bladders.—*T. Leucutia.*

GYNECOLOGY AND OBSTETRICS

Jameson, Edwin M. Tuberculosis of the female pelvis. *Am. Rev. Tuberc.*, July, 1930, *22*, 72–81.

Involvement of the genital organs ranks fifth among the complications to which the woman suffering from pulmonary tuberculosis is liable. The uterus and the adnexa are more frequently involved. Tuberculous pelvic disease occurs most frequently during the active period of menstrual life and well within the age limits at which pulmonary tuberculosis takes its greatest toll.

The usual routes of infection of the ovaries, tubes, and uterus are three: (1) blood stream, (2) infected peritoneum, (3) by continuity from adjacent intestinal lesion.

Factors predisposing to development of tuberculosis in the tubes are: (1) hypoplasia of the organs, (2) preliminary inflammation, and (3) puerperal state itself.

Diagnosis. There is no true distinguishing syndrome. The symptoms are usually lower abdominal pain, disturbances in menstruation, leucorrhea, tenderness of the tubes and ovaries, tubal masses, leucocytosis and increase in the red cell sedimentation rate.

Treatment. The treatment is one of conservatism. It is an old maxim that the unexpected sits at the elbow of him who operates for abdominal tuberculosis. Kolischer states that surgery should be restricted to most urgent indications; that is, surgical necessities. He suggested general care and judicious use of tuberculin. In 1908 Bircher suggested roentgen therapy for the following cases: (1) those with plastic peritonitis; (2) those in which cachexia contraindicates operation; (3) cases that refuse operation; (4) slight and benign cases. Siedamgrotzky concluded that beneficial effect was due to stimulation of the connective tissue. Ford, Schumacher and others reported cure or marked improvement in proved tuberculous pelvic disease in 66 to 80 per cent of cases using small doses of roentgen radiation.

Schumacher's conclusions are that no damage is produced by proper dosage; initial temperature subsides early, and every case meets with more or less success. Results are slow. Irregular or profuse menstruation is no argument for operation versus roentgen therapy. He warns against the use of radium. The treatment should consist of 10 to 30 per cent of a Holtzknecht erythema dose over the entire abdomen, front and back, with a total of 15 per cent erythema dose. Sterilization is therefore avoided.

In spite of excellent conservative reports most gynecologists still recommend surgery. The author believes that surgery should be reserved for those that do not respond to other measures.—*E. P. Pendergrass.*

Béclère, Claude. Technique de l'hystérosalpingographie. (Technique of hysterosalpingography.) *J. de radiol. et d'électrol.*, April, 1930, *14*, 219–228.

The present status of the technique of hysterosalpingography by means of lipiodol is described in detail. The best time for the injection is at the end of the first week following the menstrual period. The patient is hospitalized for a period of twelve to twenty-four hours following the injection.

The injection itself is made under manometric control of the pressure.

Following the injection the patient is examimed first roentgenoscopically and then roentgenograms are taken. The following procedures are advised for roentgenography: (1) serial films at various intervals; (2) films in profile; (3) control films twenty-four hours after the injection in case of tubal obstruction; (4) encircling of the tumors with lead wires; (5) stereoscopic roentgenograms. The article is richly illustrated.—*T. Leucutia.*

GENITOURINARY SYSTEM

Thompson, Theodore. Addison's disease; the value of radiography in direct diagnosis. *Lancet*, Oct. 11, 1930, *2*, 785–787.

The author reports a case of Addison's disease in which the clinical picture and course were characteristic and enabled him to make a diagnosis of suprarenal insufficiency. In addition to the above findings, a roentgen examination of the abdomen revealed triangular areas showing uneven calcification at the upper pole of both kidneys corresponding to the shape and position of the suprarenals.

It is suggested that a roentgen examination of the suprarenals should always be conducted in cases of Addison's disease for when a positive result is obtained it gives the only direct evidence of disease of the suprarenals. A positive roentgen finding will be obtained only in those cases where calcareous deposits are present in the tuberculous suprarenal glands and not in those cases of Addison's disease in which there is simple atrophy of the glands.—*F. K. Alexander.*

SKELETAL SYSTEM

Joseph, Benjamin M. Osteitis fibrosa cystica, generalized type, with giant cell sarcoma. *Am. J. Dis. Child.*, July, 1930, *40*, 81–88.

Joseph reports a case of osteitis fibrosa cystica of the generalized type with giant cell formation because of two reasons: (1) the rarity of the disease in infants, and (2) the rapidity with which the lesions became evident. The patient, a male, thirteen months old, was brought to the hospital for a swelling of the mandible. The roentgen examination showed a large cyst of the right mandible involving the region of the angle. There was also a similar tumor mass in the frontal bone. Within a space of two months practically the entire skeleton became involved. The histologic diagnosis of the biopsy material was large round and giant cell sarcoma. This material consisted of an excised inguinal gland.

Joseph mentions three etiologic causes of this condition: 1. Trauma, but the adherents of this theory are decreasing in number. 2 Toxicity, infection and inflammation. 3. Disturbance of internal secretory organs. Erdheim and Meyer have found parathyroid disease in association with this condition. Hamann wrote of a remarkable cure following the administration of pituitary.

He quotes Morton's general classification of all cysts of bone into cysts without giant cell sarcoma, and cyst with giant cell sarcoma. Burchard reported one case in a child of eighteen months. Roentgen examination in this disease shows in general according to Joseph: 1. The contour of the bone is changed. 2. The periosteum is smooth, with a normal outline. 3. The epiphysis and the joint surfaces are unaffected. 4. The cortex and marrow cavity are wide and irregular in outline. 5. A clear space is present which appears to be calcium poor. 6. It is difficult to tell where the cortex ends and the marrow begins. 7. There is a translucent shadow of honeycomed appearance where cysts are present.

Prognosis to life is questionable. The cases not associated with general malacia have a fair outlook. Death in these cases is caused by intercurrent disease. The differential diagnosis must be made from osteomyelitis, tuberculosis of the bones and syphilitic changes of the bone. He quotes Coley who collected 50 cases in children and saw metastasis and recurrence, and states that surgeons are not wholly convinced that the condition is benign as cases of recurrence and metastasis have occurred after amputation.

No blood calcium studies are reported in the author's case and throughout his paper he refers to giant cell sarcoma instead of the newer term giant cell tumor. Treatment consists, he states, of either the conservative method, administration of calcium and phosphorus salts, or the more radical method, surgical intervention.—*R. S. Bromer.*

Glădău, D. Osteochondrita dissecantă. (Osteochondritis dissecans.) *Cluj. med.*, Sept., 1930, *11*, 450–454.

Osteochondritis dissecans is characterized by the separation or detachment (in the form

of an intra-articular foreign body) of a portion of the chondro-osseous surface of the joint. Although several factors may act as provoking agents, the disease is most probably on a predisposing basis.

The foreign bodies are found nearly always in the knee and elbow joints. It is very exceptional that they occur elsewhere.

The author recently observed 2 cases: one (a man aged twenty-six) with unusual location of the foreign body in the coxofemoral articulation and the second (a man aged forty-two) with the foreign body which was present in the knee-joint occurring as the result of tabes, although there was no evidence of other signs of arthropathy.

The opinion is expressed that in the presence of osteochondritis dissecans with unusual localization or appearance one should always have tabes in mind, even if other symptoms are absent.—*T. Leucutia.*

Bittencourt, Januario. A propos d'un cas de spondylose rhizomélique. (A case of rhizomelic spondylosis.) *Rev. sud-am. de méd. et de chir.*, August, 1930, *1*, 787–810.

A very unusual case of rhizomelic spondylosis, occurring in a man twenty-three years of age, is described in detail and illustrated with numerous photographs and roentgenograms.

The case presented all the principal characteristics as described by Pierre Marie: ankylosis of the spine which started in the lower segments and extended upwards, without, however, involving the neck for a long time; marked kyphosis which was of a progressive character and quite different from the kyphosis observed in other affections; ankylosis of the coxofemoral and scapular articulations, the first nearly complete, the second partial; integrity of the other articulations, especially that of the knee; cracking of the affected articulations during movement; respiratory immobility of the thorax, especially following exposure to humidity or following colds; onset of the disease during adolescence; periodic pains along the spine and at the level of the affected joints and marked reduction of phosphates in the urine.

In addition to the above typical signs, there were some very unusual manifestations. The trunk of the patient dropped completely forward, the spine forming a curve, and the head practically resting on the knees, thus giving the appearance of a "question mark" posture (instead of the usual Z-posture). On account of the ankylosis, which had already occurred in the spine and in the coxofemoral joints, the patient could not straighten out even when lying down. When walking he would use a stick in his right hand and with the left hand resting on the left knee, he would take very short steps with considerable labor. Another peculiarity was that, in contradistinction to other cases published in the literature, the disease was of a rapidly progressive character. The thorax was flattened and the abdominal viscera were displaced upwards and towards the diaphragm. The kyphosis was in the lumbar and not in the dorsal spine as considered typical by Marie. Finally, there was partial ankylosis of the knee.

Differential diagnosis included arthritis deformans, heredo-traumatic kyphosis, Paget's disease and Kummel-Verneuil's disease.

The author had an opportunity to observe 4 or 5 other cases of rhizomelic spondylosis and from a study of these he arrived at the conclusion that the disease represents an endocrine disturbance. This opinion is based on the presence of anaphrodisia, osseous dystrophy, disproportion of the extremities, lack of development of secondary sexual characters, etc. Unfortunately a roentgen examination of the sella turcica could not be made in the above case on account of the marked invalidism of the patient. All that can be said at the present time is that the endocrine factor plays a considerable part in the pathogenesis of rhizomelic spondylosis. It remains for the future to bring conclusive proof.—*T. Leucutia.*

Schneider, Chester C. Double isolated compression fracture of the spine. *J. Bone & Joint Surg.*, July, 1930, *12*, 595–599.

Schneider reports 3 cases of double isolated compression fractures of the spine and emphasizes the frequency of this occurrence. The first case showed on roentgen examination compression fractures of the sixth and ninth dorsal vertebrae, the second case, fractures of the fifth and tenth dorsal, while the third showed involvement of the sixth, seventh and eleventh dorsal vertebrae. All the roentgenograms are reproduced with traced outlines of the vertebral bodies. The mechanism of production of the fractures in the first two cases was that of jack-knifing or hyperflexion of the spine, which is generally recognized as the usual method of

production of all spinal fractures. But in the case of isolated double fractures, the force must be greater or longer sustained so that the crushing effect is not dissipated or exhausted with the compression of one vertebral body, but continues on to the second. In instances where the transitional region between the dorsal and the lumbar spine shows one fracture it is conceivable that the primary crushing force was directed to the mid-dorsal or mid-lumbar region and extended secondarily to the dorso-lumbar junction. The transition from the dorsal to the lumbar spine is the region least adapted to yielding to indirect violence.

Schneider found 12 cases previously reported in the literature with from one to eight normal vertebrae intervening between those which were fractured. From this material there seems to be a predilection for involvement of the eleventh dorsal to the second lumbar bodies. The important deduction to be drawn is that they occur with probably greater frequency than is evident from statistical study because they are generally overlooked. If one compression fracture is found, the observer should not be content with this single finding but should carry his investigation beyond this point.—*R. S. Bromer.*

Cone, Sydney M. Syphilis of bone. *J. Bone & Joint Surg.*, July, 1930, *12*, 600–602.

Cone briefly reports the pathological findings in 100 cases of syphilis which came to autopsy. He describes new bone formation, and the ribs of syphilitics invariably demonstrate this change. The periosteum is cellular and the new bone is usually seen in new strata at the periosteum. Frequently the strata are interrupted by irregular zones of branching layers which contain haversian canals. Necrotic areas are often found. The trabeculae (cancelli) frequently give evidence of new bone layers. Sometimes osteoblasts border the new strata. The new formation often rims the entire rib. Nodules of new bone (osteophytes) are seen in some ribs at irregular intervals at the periosteum. In old, long-continued cases of syphilis with a cardiovascular history, the bone resembles Paget's osteitis deformans. The marrow does not invariably show serious involvement but often appears hyperplastic. The only pathognomonic findings are gummata. The vessels are frequently fibrosed. There is no evidence of lacunar absorption in the less pronounced cases. There is no round cell infiltration in the new periosteal bone strata.

Cone infers that there must be a poison present which stimulates the connective tissue substance (matrix) to hyperplasia. With edema, congestion, calcium, and modified connective tissue, the elements are present which Leriche and Policard assert are prerequisites for bone formation. When familiar with the pathological changes of the ribs as described above, one can without fail diagnose syphilis from the rib alone.—*R. S. Bromer.*

Mayer, Leo, and Sashin, David. Report of a case of supernumerary foot. *J. Bone & Joint Surg.*, July, 1930, *12*, 649–653.

Supernumerary toes are frequently seen but a supernumerary foot is a congenital anomaly which is extremely rare. The authors could find no reported cases in the literature. On the left lower extremity of their case, nine toes could be counted, four belonging to a mesial foot and five to a lateral foot. There was no line of cleavage between the two feet, except just posterior to the toes. The heel of the left extremity was almost twice as broad as that of the right, normal foot.

Roentgenograms confirmed the presence of nine left toes, each with its normal phalanges and corresponding metatarsals. The metatarsals of the lateral foot were thinner than those of the mesial, and the fourth of the lateral foot was fused to the fifth at its base. The ossification centers of the os calcis, astragalus and cuboid showed the same grade of development in all three feet. The astragalus of the left mesial foot articulated with the tibia so it was easy to decide which of the two feet should be removed at operation. The lateral foot was removed and an excellent result was obtained. Roentgenograms are shown of the mesial foot two years and ten months after operation.—*R S. Bromer.*

Mitchell, Joseph I., Dislocation of the knee. *J. Bone & Joint Surg.*, July, 1930, *12*, 640–646.

Mitchell reports 4 cases of traumatic dislocation unassociated with any other lesion such as fracture of one of the constituent bones. This is a comparatively rare occurrence. In commenting on these cases Mitchell states the knee is involved in pathologic and traumatic processes more often than any of the other

joints, but traumatic dislocations are seldom observed because separation of the articular surfaces requires the severance of many strong ligaments which can be produced only by great forces. In 3 of his cases the tibia was displaced anteriorly and in the fourth posteriorly. The functional result is often much better than would be anticipated. If the reduction is secured early, the joint immobilized until healing of the soft tissues occurs, and the after treatment carried out under proper supervision, the ruptured ligaments re-unite and a practical range of motion is restored to the joint without pain or appreciably diminished endurance.

Penetration of the skin in the popliteal space by the lower end of the femur is a serious complication. Injuries to the popliteal nerves, particularly the perineal nerve, and to the blood vessels are not unusual and gangrene may be inevitable in those with impairment of the circulation making amputation above the knee necessary.—*R. S. Bromer.*

Lapidus, Paul W. Epiphyseal separation of the lesser femoral trochanter. *J. Bone & Joint Surg.*, July, 1930, *12*, 548–555.

Lapidus reports a case of epiphyseal separation of the lesser femoral trochanter. He also reports a second case which though clinically apparently similar to the first, showed no bony lesion in the roentgenograms and was interpreted as a partial rupture of the tendinous fibers of the ilio-psoas muscle. Cases of epiphyseal separation of the lesser trochanter are quite rare, occurring mostly in boys between the ages of thirteen and seventeen, as a result of a sudden exertion of the ilio-psoas muscle, mostly during running. Symptoms and signs of this separation are pain and tenderness over the lesser trochanter, weakness and complete loss of flexion of the thigh, Ludoff's sign which consists in the inability to raise the thigh actively from the sitting position, though some active flexion of the thigh may be present in the recumbent position, and the peculiar gait which is due to deficient flexion of the thigh.

Lapidus recommends treatment consisting of rest in bed with relaxed ilio-psoas muscle or immobilization by means of a plaster-of-Paris spica with the thigh in flexion, external rotation, and adduction; he does not regard operation as justifiable. Complete recovery with premature fusion of the epiphysis of the lesser femoral trochanter usually takes place in all cases.—*R. S. Bromer.*

Kreuscher, Philip H., and Hueper, W. C. The histology of the postoperative healing process in chronic osteomyelitis and its prognostication from biopsy sections. *J. Bone & Joint Surg.*, July, 1930, *12*, 541–547.

The authors made clinical observations on 207 consecutive cases of chronic osteomyelitis in an attempt to answer the following questions:

1. How does bone regenerate in the presence of infection?

2. Is there any effort at reformation of medullary structure?

3. Does cortical bone tissue actually regenerate, or is it replaced by spongy bone and connective tissue?

4. Does periosteum form over healed bone?

5. Is it possible to prognosticate from biopsy sections of the granulating surface whether healing will be prompt, delayed, or whether a subsequent operation will be necessary to bring about a rapid and complete closure of the wound?

Their comments and conclusions follow:

1. The bony defect is filled in by the production of three different zones of tissue formed in succession, namely, granulation tissue, strong fibrous and hyalinized connective tissue, and loose connective tissue with lamellae of osteoid and osseous tissue. The presence of an infection interferes to a greater or lesser extent with the formation and arrangement of these structures and therefore greatly retards regeneration of bone.

2. In the sections examined no evidence of a reformation of medullary tissue was found. A loose, sometimes edematous connective tissue was present between the bony lamallae.

3. In only one of the cases examined was an attempt at cortical bone formation apparent. In this case complete epithelization of the defect had existed for six months. Cortex formation is evidently a process of a late period of bony regeneration.

4. The same condition was found in regard to the formation of periosteum. Elastic tissue was only scantily present in the tissue covering the spongy bone.

5. While definite conclusions cannot be drawn from the limited number of cases examined, the present findings seem to indicate that a prognostication of the postoperative healing

process of chronic osteomyelitis from biopsy sections is possible and renders valuable information in regard to the therapeutic management of the individual case.—*R. S. Bromer.*

Haret, Colaneri and Roederer. Radiothérapie du corps thyroïde et fracture du col du fémur. (Radiotherapy of the thyroid gland and fracture of the neck of the femur.) *Bull. et mém. Soc. de radiol. méd. de France*, June, 1930, *18*, 236–239.

Two cases in which, according to the authors' assumption, there was a relation between dysfunction of the parathyroid gland and subsequent fracture of the neck of the femur are briefly described. In the first case, that of a woman aged seventy, there was a typical Basedow syndrome and an intracapsular fracture of the neck of the left femur occurred as the result of an accident. For six months there was normal progress in the callus formation, then a secondary resorption of the osseous substance with marked decalcification of the head of the femur ensued. Following administration of thyroid extract there was improvement in the calcification but the pseudoarthrosis persisted. This patient never received any roentgen therapy.

In the second case, that of a woman aged fifty-one, there was a hypertrophy of the thyroid gland which was successfully treated with ten applications of the usual roentgen irradiation. A few months later the patient developed, as a result of a light trauma, a fracture of the neck of the left femur. Here also at the beginning there was a satisfactory callus formation but later resorption of the callus with decalcification of the head of the femur and pseudoarthrosis resulted.

The opinion is expressed that the changes in the parathyroid metabolism (in the first instance brought about by the Basedow syndrome and in the second by the effect of the roentgen therapy) might have had something to do with the unsatisfactory healing of the fractures. It is recommended that in such instances parathyroid opotherapy and ultraviolet irradiations be applied in order to improve the calcium metabolism.—*T. Leucutia.*

Sigurdson, Larsus Arthur. The structure and function of articular synovial membranes. *J. Bone & Joint Surg.*, July, 1930, *12*, 603–639.

The author undertook this investigation because of the uncertainty and disagreement that still exist regarding the structure of synovial membranes. At the present time he states there is no agreement regarding the anatomy and physiology of the synovial membrane in spite of many investigations on the subject. He gives an extensive review of the literature and reports his investigations in detail.

His summary follows:

1. The inner surface of articular capsules is not formed by a distinct membrane, but by connective tissue modified as the synovial surface is reached. The cells are more closely packed and the neuclei exhibit peculiar staining characteristics, but that does not seem to justify the use of the term membrane.

2. The superficial synovial cells are not uniform in shape or size, some being quite small and round while others are large with branching processes. This type of cell is not confined to the surface.

3. Synovial villi vary greatly in size and shape and are composed of connective tissue resembling the part of the capsule from which they arise.

4. An excellent demonstration of variation in cell outlines on the synovial surfaces of articular capsules can be obtained by the use of silver impregnation methods. The intercellular substance is found to be abundant, in contrast to that of the pleura and peritoneum; and the apparent cell outlines are much more irregular and do not resemble those of an endothelial or mesothelial layer.

5. The presence of "stomata" in articular capsules is not confirmed.

6. Carbon particles, when injected into the knee joints of guinea pigs, evoke an inflammatory exudate in the joint cavity, most marked on the third day after injection. Some of these carbon particles are taken up by the lymphatic vessels and are deposited in the inguinal and lumbar nodes, while others are removed from the joint cavity by the action of phagocytic cells, some of which gain the lymphatic vessels while others remain in the subsynovial connective tissue for an indefinite period.

7. Iron, in the form of ferric ammonium sulphate, disappears from joint cavities within thirty minutes after injection by way of the lymphatics.

8. Iodin in the form of lipiodol diffuses slowly through the joint capsule, a period of at least four days being required for its complete removal, as judged by roentgenograms.

9. Immobilization of the tibiotarsal joints in rabbits over fifty-three days produced no marked structural changes in the joint capsule, but the amount of synovial fluid was considerably less.—*R. S. Bromer.*

Wagner, Lewis Clark. Intraarticular endothelial tumors arising from synovial membrane. *Ann. Surg.*, Sept., 1930, *91*, 421–424.

Two cases of solid tumors arising from the synovial membrane of joints are reported. The first is from the knee while the second is from the ankle joint. Microscopic study of these tumors resulted in the diagnosis of fibro-endothelioma.

These tumors are of rare occurrence. They are definitely encapsulated, attached to the synovial membrane and adapt themselves to their position in the joint. The symptoms consist of a more or less constant pain, dull, aching in character and it becomes impossible to place the joint in a comfortable position.

The diagnosis is difficult. There is swelling in only one part of the affected joint. No particular tenderness or increase in joint fluid. The range of motion is rarely affected. The diagnosis is further augmented by the careful study of the roentgenograms with special attention to soft tissue structures. This will show a soft tissue tumor in close relation to the joint.

The treatment is surgical. Even with complete removal, they are prone to recur. Roentgen treatment or Coleys' toxin may be tried, but so far no cures are reported.

The tumors are removed as often as they recur and usually end with amputation.—*Karl Kornblum.*

Geschickter, Charles F., and Copeland, Murray M. Recurrent and so-called metastatic giant cell tumor. *Arch. Surg.*, May, 1930, *20*, 713–755.

This paper is an attempt to clearly define a small group of giant cell tumors frequently referred to in the literature as metastatic giant cell tumor, and to establish the relationship of such tumors to osteogenic sarcoma. Goforth has attempted to grade the microscopic picture to show the gradual transition of benign giant cell tumor to osteogenic sarcoma. The authors show that however logical the existence of such histologic gradations toward a malignant condition may appear, a survey of the data from many different sources does not support such contentions. For the purposes of analysis it has been found convenient to group the lesions under discussion into four groups.

Group 1. Benign Giant Cell Tumor with Clinical Features Leading to Recurrence

Microscopic Analysis. A study of the 26 cases in this group showed that the original tumor possessed the characteristic histologic structure of giant cell tumor in each instance. A study of the tissue removed after recurrence showed no histologic change toward osteogenic sarcoma or what may be called a malignant giant cell variant. Unless the lesion has become infected, the histologic change following recurrence is usually characterized by an increase of fibrous tissue. Occasionally foam cells, characteristic of the xanthoma group of tumors, are found. These, the writers believe, are associated with perforation of the bony capsule and extension of the tumor into neighboring soft parts which furnish the lipoids characteristic of these xanthoma cells. It is shown that the microscope is of no aid in disclosing the reasons for recurrences.

Clinical Features Leading to Recurrence. In an analysis of 105 cases treated primarily by curettement there was found a definite tendency for the giant cell tumor to recur more readily in persons more than twenty-one and even more frequently in those over thirty. This is to be explained by the fact that cortical bone declines in its power to heal and ossify after the age of twenty-one. Cortical bone is a primary factor in the healing reaction about a giant cell tumor.

Recurrence is also dependent upon the site of the tumor. In the three most common locations of giant cell tumors the incidence of recurrence is as follows: upper part of tibia, 8 per cent; lower end of femur, 39 per cent; and lower end of radius, 50 per cent. In the radius the bone shell is most commonly destroyed because in this non-weight bearing bone the disease has usually progressed considerably before severe symptoms arise. This is evidenced by the fact that the average duration of symptoms is twenty months in the radius compared with fourteen months for the usual giant cell tumor. The most valuable asset in the care of a giant cell tumor is the preserved shell of cortical bone

with an intact and competent vascular supply.

Improper treatment constitutes the major cause for recurrences. Resection rather than curettement should be done in tumors that have destroyed too much of the bone shell, especially when involving the radius, fibula and humerus where good function is to be had after resection with transplantation of bone. Incomplete curettement, failure to use chemical or thermal cauterization after curettement and removal of too great amount of the cortical shell predispose to recurrence. The fact that no giant cell tumor has recurred after primary radical resection or amputation emphasizes the fact that the mode of treatment and not the histology of the tumor is the primary factor in recurrence.

Group. 2. Giant Cell Tumors which Resemble Sarcoma Microscopically, so-called Malignant Variants.

In 7 cases in this group the histologic change resembling malignancy was found to be due to either necrosis from poor fixation, alterations dependent on recurrence and infection: modifications due to partial healing with fibrosis, changes brought about by irradiation or by infiltration of adjacent tissues.

Special emphasis is laid upon the importance of infection producing changes simulating malignancy. In any case in which a bone tumor containing frequent large giant cells averaging over 15 nuclei per cell is seen with evidence of round cell and polymorphonuclear infiltration and frequent areas of hemorrhage surrounded by young loose fibrous tissue, the pathologist should be on his guard against making a diagnosis of sarcoma and wary lest the apparent malignancy of the nuclear material is in reality pycnosis and cloudy swelling dependent on infection and degeneration.

In 2 cases actual sarcoma with giant cells were found to be erroneously placed in this group. Cause for such errors is to be found in the failure to recognize the giant cell invasion of osteogenic sarcomata of the chondroblastic variety. In such tumors characterized by an abortive form of chondromatrix transformed here and there by calcification the giant cell invasion represents an attempt on the part of the normal bony structures to vascularize and resorb this malignant tissue by a process typical of the resorption of normal calcifying cartilage in the human embryo.

Group 3. Those Giant Cell Tumors which are Associated Clinically with Metastases and Death.

In this group there were 8 cases available for analysis. These 8 cases fell into 3 subdivisions. In the first subdivision were 2 cases in which death had been attributed to metastasis from a giant cell tumor but on analysis it was found that death, in one case, was due to pulmonary embolism and in the other, to cardiac decompensation followed by pneumonia. In 4 cases in second subdivision, while death was due to metastasis of an osteogenic sarcoma, the nature of the primary lesion was *not proved*. In the first place, the primary tumor may have been a slow-growing sarcoma and not a giant cell tumor and, secondly, a sarcoma may have developed at the site of an unsuccessfully treated and unhealed giant cell tumor. The form of osteogenic sarcoma present in these cases of recurrent lesions resembled a type of fibroblastic origin, which is usually slowly fatal and occurs generally in patients over thirty. Two cases in the third subdivision were originally clinically and microscopically osteogenic sarcoma and not giant cell tumor.

The conclusions to be drawn from this group are that in no case has transformation of giant cell tumor into sarcoma been proved, and in no case have typical giant cell tumor nodules been found as metastases in the lungs.

Group 4. Osteogenic Sarcoma Containing Giant Cells and Resembling Microscopically Giant Cell Tumor.

The authors, on embryologic, histologic and clinical grounds, recognize two broad and well-defined groups of osteogenic sarcoma—the chondroblastic and the fibroblastic series. While giant cell areas are not primarily characteristic of either of these types, they may be found in both.

In the slow-growing fibroblastic type of osteogenic sarcoma, particularly in those cases in which operation has been performed unsuccessfully and in which there have been recurrences, foci of necrotic bone will be present, and giant cells on a phagocytic errand will invade the tumor. Such areas may lead to the erroneous diagnosis of giant cell tumor.

The chondroblastic sarcoma composed of more primitive tissue than the fibroblastic type grows more rapidly and is more malignant. In an analysis of 33 such cases remarkably uniform features were found. Thirty of the cases

occurred within the narrow age limit of fourteen to twenty. Likewise 30 occurred in the lower extremities with a period of symptoms averaging less than six months, and an average duration of life after operation of less than eleven months. In such tumors giant cells may occur. These cells attempt to resorb the abortive calcified cartilage of the chondroblastic tumor, according to the usual embryologic process for substitution bone. Under such conditions the giant cell tumor may be simulated.

The article is concluded by a review of the results of various types of treatment in over 200 cases of giant cell tumor. Amputation, then resection, and curettement have prevailed as the treatment of choice, and now roentgen therapy alone is being advocated by some. All of these methods are indicated in selected cases but curettement followed by chemical or thermal cauterization is the method of choice in most instances. Roentgen therapy, as Bloodgood has pointed out, when compared to proper curettement, is more uncertain, often more prolonged, and does not offer the benefits of microscopic diagnosis in doubtful cases. Irradiation has failed to prevent recurrences and when recurrence has taken place experience has shown that little can be expected from roentgen therapy. The implantation of radium into the wound following operation for giant cell tumor has not been successful.—*Karl Kornblum.*

BLOOD AND LYMPH SYSTEM

Dyes, Otto. Anämie, Zellalter und Radiosensibilität. (Anemia, age of cells and radiosensitiveness.) *Strahlentherapie*, 1930, *36*, 552–561.

When an arched Holfelder tube is used to bring about pressure anemia the radiosensitiveness of the matrix cells of the roots of the hair in the irradiated regions is decreased. The hair in the region does not fall out immediately even after the application of an erythema dose, or 640 r, but falls out gradually in the course of several months, which indicates that the difference between the epilation dose (50–60 per cent of an erythema dose) and the dose that causes a epilation of anemic scalp is quite large. There is a similar difference between the radiosensitiveness of the hair papillae that were first irradiated and the young ones that grow in after epilation. When a dose of the same size (212/180 kv., 5 ma., stabilivolt, Holfelder apparatus, 0.5 Cu) was given four months after the application of an erythema dose, the falling out of the hair was also delayed. So it is evident that even four months after the first epilation a considerable increase of dosage is necessary to bring about epilation of the young hair.—*Audrey G. Morgan.*

GENERAL

Mason, James B. Desmoid tumors. *Ann. Surg.*, Sept., 1930, *92*, 444–453.

A report of 50 cases of desmoid tumors observed at the Mayo Clinic during the years 1910 to 1929, inclusive. These were studied from the points of view of clinical and pathologic phenomena and of recurrence.

The term desmoid tumor is used at the Mayo Clinic to designate benign fibroma arising from musculo-aponeurotic structures. Reference is made to the literature on the subject. Nothing is added to the etiology.

This type of tumor has seldom caused symptoms, other than by reason of its presence, its size or interference with function. They are most frequently found in the muscles of the abdominal wall. Here they may be confused with intra-abdominal tumors. They have never been known to cause death.

Pathologically the tumor is benign but prone to recur unless completely removed. The tumor is discrete, very firm, as a rule movable, rounded, of variable size, and may be situated subcutaneously or on the posterior surface of a muscle. The freshly removed tumor is pinkish white, cuts with difficulty, and the knife creaks as it proceeds through the tissue. The cut surface resembles neurofibroma owing to the intertwining bands of connective tissue which characteristic led Johannes Müller to name the tumor desmoid.

Histologically, these tumors resemble, at first glance, fibrosarcomas of low grade. There is no capsule or definite line of cleavage between the tumor and the adjacent muscle which is infiltrated by the tumor tissue. The tumor grows slowly and does not metastasize. Recurrences are at the site of the primary tumor.

Treatment is by surgical excision, removal being as wide as the physical condition will permit. The few cases treated by radium or roentgen rays were unsuccessful.

Data were collected from 39 of the 50 patients relative to recurrences. Among this number were 4 recurrences.—*Karl Kornblum.*

ROENTGEN AND RADIUM THERAPY

Simons, Albert. Zur Therapie der Keloide und Narbenhypertrophien. (Treatment of keloids and hypertrophied scars.) *Strahlentherapie*, 1930, *37*, 89–123.

Halberstaedter's method of treating keloids and hypertrophied scars by introducing rods of thorium X into them is described in detail and the histories of 21 cases treated in this way are given. The advantages of this method as compared with irradiation from the surface are as follows: (1) It can be used successfully in some cases in which the technique of irradiation heretofore in use gives little or no prospect of success. (2) Large deep doses can be attained with much less burden on the skin around the structures to be treated. (3) Adjacent and deeper organs are in less danger from the rays. (4) The deeper layers of tissue can be subjected to the action of beta rays, which are generally acknowledged to be particularly useful in the treatment of connective tissue proliferations. (5) A protracted, continuous radium treatment, which is now generally acknowledged to be more effective than the same dose given in short irradiations, can be given with much less expenditure of radioactive substance and the patient need not be kept in the hospital. As compared with combined surgical-radiotherapeutic treatment it has the following advantages: (1) The method can be used in cases in which operation is contraindicated. (2) There is no danger of recurrence at the treated places. (3) The scars that result from the treatment are limited to the boundaries of the original pathological new-growth.

Thirteen of the cases described were completely cured. In 4 cases the results were so bad from previous treatments that successful results could hardly be expected; in 2 other cases the results were relatively slight but the patients said they were satisfied. In the other 2 the reaction is not yet over with so it is impossible to say what the final result will be.—*Audrey G. Morgan.*

Hoede, Karl. Röntgenschädigung nach Epilationsbestrahlung bei Hypertrichosis. (Roentgen injury after epilation by means of irradiation in hypertrichosis.) *Strahlentherapie*, 1930, *36*, 727–731.

A woman, aged twenty-four, was admitted to the hospital for roentgen injury. When she was eighteen she had a heavy growth of beard for which she was irradiated. She was given 14 irradiations of the whole region of the beard in the course of a year. A year later she showed slight skin changes and after another year slight ulcer. Almost four years after the irradiation an ulcer developed under the chin in the region that had received the least irradiation. This ulcer followed a tooth fistula. In another case a woman, aged thirty, was irradiated for hypertrichosis of the chin. Nine years later she came to the hospital and said that the growth of hair had not returned and she had not had any skin symptoms until a short time before when after exposure to cold her skin became red and atrophic. There were many pigment spots and new-formed vessels in the pigmented area and a feeling of tension that she had never had before.

The resistance of the skin to external injury is decreased by roentgen irradiation and this decreased resistance persists for years. In both these cases the injuries caused by the rays were more disfiguring that the hypertrichosis. Roentgen irradiation should therefore not be used for epilation.—*Audrey G. Morgan.*

Delherm and Laquerrière. Note sur la radiothérapie dans les périviscérites douloureuses. (Radiotherapy of painful perivisceritis.) *Bull. et mém. Soc. de radiol. méd. de France*, June, 1930, *18*, 239–243.

Six cases of perivisceritis treated by roentgen therapy are briefly described. In one case there was aggravation, in another a slight amelioration and in 4 cases a very marked amelioration of the pain, nausea and vomiting. After discussing the various theories of the effect of roentgen rays in such instances, the authors recommend that the method be used whenever other therapeutic procedures have failed. In certain instances the association with diathermy is of certain advantage.—*T. Leucutia.*

Fuhs, Herbert, and Konrad, Josef. Uber die Allgemeinbehandlung von Hautkrankheiten mit Buckys Grenzstrahlen. (General treatment of skin diseases with Bucky's borderline rays.) *Strahlentherapie*, 1930, *36*, 520–527.

Bucky, Spiethoff and others reported successful treatment of various dermatoses with borderline rays. But the authors treated 104 cases of various kinds of skin diseases by general irradiation with borderline rays and did

not find the treatment of any great value. Since some good results have been reported and the apparatus and measurement of the rays is not yet perfected it seems possible that with improved technique this general use of borderline rays may be of value in some common skin diseases. At present only local use of the rays appears equal in value to other radiotherapeutic methods of treatment of skin disease or even in many respects superior to them.—*Audrey G. Morgan.*

Ward, Roy. Radium treatment of epitheliomata of the skin. *Brit. M. J.*, Sept. 27, 1930, *2*, 511–513.

In this paper the author considers mainly the subject of rodent ulcer and barely mentions squamous epithelioma, as he believes the latter lesion is primarily a surgical one unless very far advanced and then radium is used only palliatively.

The rodent ulcers are divided clinically into the flat, smooth, waxy, pearly, semi-translucent nodules which are considered as the hypertrophic variety. These growths extend only a little beyond the surface and are treated primarily with the beta rays, the factors being unscreened radium concentrated at 5 mg. per square centimeter of applicator, the time depending on the thickness of the lesion. With this treatment approximately 90 per cent are cured. When the hypertrophic growths are rather large the author prefers buried radium needles containing 2 mg. of radium per centimeter of active length screened with 0.3 mm. of platinum. With this technique the needles are buried in and around the growth, being concentrated at the periphery with no area of the lesion more than 1 cm. from a source of irradiation. The time of application depends upon the size of the lesion though not in any case are the needles left in for more than seventy-two hours.

The second clinical group are those lesions of the small hypertrophic variety which have ulcerated superficially at the center. This type is usually treated similarly to the larger non-ulcerated hypertrophic type with unscreened radiation. When the ulcer is larger, a light screen consisting of 0.1 mm. of lead is used, leaving a more penetrating type of ray which requires a longer period of application.

The deeply ulcerated variety is the most severe form of basal cell epithelioma and the most difficult to treat. Although there may be extensive local destruction of tissue, these growths never give rise to metastases unless they assume the clinical and histological appearances of a squamous-cell epithelioma. Occasionally this occurs and it is important to recognize this transitional type. In these lesions the author advises large amounts of radium screened through 2 mm. of lead, the time period never exceeding seventy-two hours. This time limit is set so as to insure no damaging effect on the normal tissues. Radium needles or screened seeds may be inserted into the lesion. If bone or cartilage has become invaded by the lesion a shorter exposure time is advisable since these structures have a great tendency to radium necrosis. The results in this class of ulcer are not so good and if no improvement is noted in two months, surgical excision and skin grafting should be employed.

The author maintains that radium should never be employed within six weeks of any previous treatment. Occasionally repetition of radium treatment is necessary, though it is best to give a maximum dose at the first application as a rodent ulcer becomes refractory to treatment. When a repeated dose is indicated by the presence of induration the writer employs the use of a thicker screen to affect the deeper limits of the lesion.

The prognosis depends on the age of the patient, the type of growth, its position and the extent of the lesion when treatment is commenced. In older people there is less resistance to the advance of the disease and the power of repair is deficient. Ulcers involving the forehead, ear, and inner canthus have a serious prognosis and when a mucous membrane is involved, the condition proves more resistant and is often only eradicated by free excision. An ulcer secondarily infected responds poorly to irradiation and occasionally the sepsis is aggravated by treatment.—*F. K. Alexander.*

Backmund, Karlheinz. Weitere Erfahrungen mit der Röntgenbehandlung der Hirntumoren. (Further experience with the roentgen treatment of brain tumors.) *Strahlentherapie*, 1930, *37*, 59–78.

Störmer and Gotthard in 1928 reported the results of roentgen treatment of brain tumors at the Munich Institute of Roentgenology. This article reports the later course of those cases and describes the cases that have been treated since then. Among 28 cases available

for statistical purposes 8 may be considered clinically cured, 3 as permanently improved, 4 temporarily improved and 9 unimproved; 1 patient died immediately after the first irradiation and as a result of the irradiation. But in spite of this accident it is shown by surgical statistics and results that roentgen irradiation need not be preceded by a decompression trephine. Experience shows that irradiation should first be given and the indications for operation determined from the results of the irradiation. Many questions are still unsettled in regard to the mode of action and permanence of cure. The author advises operating on all brain tumors that can be definitely localized and irradiating all others.—*Audrey G. Morgan.*

Astier, André. Résultats et indications de la radiothérapie dans le goitre exophthalmique. (Results and indications of radiotherapy in exophthalmic goiter.) *Bull. et mém. Soc. de radiol. méd. de France*, June, 1930, *18*, 275–278.

Thirty-six cases of exophthalmic goiter were treated by roentgen therapy with the following results: (1) 9 advanced cases. Complete healing, 4; marked amelioration, 2; amelioration, 1; failure 2. (2) 19 moderately advanced cases. Complete healing, 3; great amelioration, 5; amelioration, 8; failures, 3; (3) 8 mild cases. Complete healing, 3; great amelioration, 3; amelioration, 1. Thus a complete healing was obtained in 28 per cent; considerable amelioration in 30 per cent; amelioration in 28 per cent, and failure in 14 per cent of the cases.

The following conclusions are arrived at: (1) Toxic adenomas are not amenable to roentgen therapy. (2) The very severe cases of true exophthalmic goiter often lead to remarkable results. A complete healing is obtained in more than half of the cases. (3) The mild or "fruste" cases are favorably influenced by the radiation in nearly all instances. (4) In the moderately advanced cases distinction must be made between the acute and the chronic forms. The acute forms lead to very good results. The chronic forms, especially if refractory to a few seances of roentgen exposure, are best treated by surgery.

The author applies the fractional protracted method by treating weekly or bi-weekly for a total of 10 to 12 exposures. Medium penetrating roentgen rays are used, a dose of 200 r per portal (two lateral and occasionally a third median) being administered. The series may be repeated at intervals of three months.—*T. Leucutia.*

Dévé, F., and Lessertisseur. Inefficacité actuelle de la radiothérapie pénétrante et de la diathermie á l'égard du kyste hydatique. (The present inefficiency of penetrating radiotherapy and diathermy in hydatid cyst.) *Bull. et mém. Soc. de radiol. méd. de France*, June, 1930, *18*, 263–267.

In 1924 José Arce announced that penetrating roentgen therapy possesses a destructive action on the echinococcic scolex, thus leading to "sterilization" of the hydatid cyst. As a result of this communication Dévé and Decoularé-Delafontaine who had previously arrived at opposite conclusions, repeated their experiments, but they could produce neither a morphologic nor an immediate biologic alteration of the scolex. Later Proust reported an additional unfavorable case. On the other hand, Bec and Michel-Béchet and Bourde obtained good results following irradiation of secondary echinococcosis of the peritoneum.

The authors recently had the opportunity to treat 2 cases of echinococcosis, using in one a combination of roentgen therapy and diathermy and in the second diathermy alone. These 2 cases, as well as the technique employed, are briefly described.

The opinion is expressed that at least for the present, roentgen therapy and diathermy have proved entirely ineffective in the treatment of hydatid cysts. Therefore surgery, which forms the method of choice in the solitary cysts, is to be preferred also in the secondary generalized echinococcosis. Often good results were obtained by methodically repeated operations.

In inquiring from Bourde with regard to the outcome of his case, the authors recently received a letter in which Bourde admits that although there was improvement in the general condition of the patient the cysts have continued to grow, there being no arrest in the evolution of the process. On the other hand, a letter received from Bec and Michel-Béchet states that their case still enjoys good health, the hydatid cysts having disappeared.—*T. Leucutia.*

Schulte, G. Röntgenbehandlung der Tonsillenerkrankungen. (Roentgen treatment of diseases of the tonsils.) *Strahlentherapie*, 1930, *36*, 708–715.

The author has been irradiating the tonsils since 1924. He tried to find the smallest effective dose in order to avoid injuring the many lymph glands of the region which are particularly sensitive to irradiation. The patient lies on his back with his head turned to one side. The tube is placed at the angle of the jaw and the rays directed upward and backward in order to strike the pharyngeal as well as the palatal tonsil. Focus-skin distance 30 cm., field 6×8. Children are given 140 kv., through 4 mm. aluminum, 1/3 skin erythema dose (147 r), adults 210 kv., 1 mm. copper and 1 mm. aluminum, 1/3 erythema dose (170 r). The second irradiation from the other side is given in the same way the next day or the day after in order to avoid too intense reactive swelling. Homogeneous irradiation of the whole pharyngeal ring is not used. The same cycle of irradiation is repeated after four weeks and again after eight weeks if necessary.

In the course of six years the author has irradiated 257 patients, 132 children and 125 adults; 90 per cent of these were cured, 6 per cent improved and 4 per cent not improved. Large, hard fibrous tonsils did not contract very much. The author now generally operates on such cases; softer hypertrophied tonsils return to their normal size. The treatment is particularly effective in chronic recurrent anginas. Several patients who had chronic recurrent polyarthritis, the attacks generally following attacks of angina, were relieved of their symptoms.

Roentgen treatment has the advantages over tonsillectomy in that it does not require anesthesia, there is no shock, no loss of work, no danger of primary or secondary hemorrhage, no possibility of infection and no lung complications or ear infections. It is often impossible to perform operation, while roentgen treatment is always possible.—*Audrey G. Morgan.*

Cade, Stanford. Radium treatment of cancer of the tongue. *Lancet*, Sept. 20, 1930, *2*, 630–632.

The author brings out the important factors which in his experience of treating 169 unselected cases of lingual cancer have proved to be the most successful and satisfactory.

All the cases were treated by the implantation of radium needles into and around the tumor. The needles contained 0.6 mg. and 1.3 mg. of radium element screened by 0.5 mm. and 0.6 mm. of platinum respectively. Needles are preferred to seeds, as more accurate distribution is possible and there is less likelihood of having non-irradiated areas and so possible sites for future recurrences. The impression that results are more permanent with radium salt than with emanation is based upon actual cases, and is possibly due to the uniform intensity being maintained throughout the whole period of treatment with the former. The needles are preferably left in for seven days though in extensive lesions re-needling is preferable to larger doses left in for the same period of time. Cases of carcinoma of the posterior part of the tongue were needled through a pharyngotomy with good results. Surface application to the tongue was not used. In the cases too advanced for needling, seeds were used and glossectomy by the diathermy was employed.

The author advises protection of the roof of the mouth when the amount of radium in the mouth exceeds 6 mg. as a safeguard against radium burns of the palate.

In the treatment of the cervical area the cases are divided into three groups: (1) unpalpable glands, (2) palpable glands, and (3) inoperable glands. The treatment differs in each group.

The group with unpalpable glands were all treated by needling with radium, the distribution of needles extending from the mastoid process to the clavicle and providing efficient irradiation in the submental, submaxillary, anterior and posterior triangles of the neck. As an alternative to this a radium collar can be used though needling is, as a rule, preferred by the patient.

When the glands are palpable the choice lies between "open needling" after providing access to the glandular area by surgical means or operative removal by block dissection. The latter procedure is indicated only if the following conditions obtain: (1) the primary lesion must have entirely disappeared; (2) the glands must be absolutely operable; (3) the general health of the patient must be good. Insertion of radium in the neck after operation is not advisable and irradiation by a collar is the method of choice.

In the case of inoperable glands palliation only is aimed at and in this group seeds are used for needling.

The author does not describe the size of the radium needles used.—*F. K. Alexander.*

Adair, Frank E. The response of various types of breast cancer to radiation. *Radiology*, 1929, *13*, 319–322.

Unfortunately, marked radiosensitivity of a breast cancer is no criterion of the ultimate ease of cure. As a matter of fact, the more radiosensitive a carcinoma, the more cellular; the more cellular, the more dangerous, and the more subject to distant metastases. The desire and purpose in treating them is to obtain not only tumor-disappearance, but, what is even more important, tumor-restraint. Radiation accomplishes the latter by the locking-up processes of fibrosis, lymphocytic infiltration, and calcification. Surgery today, in the best clinics, is accomplishing from 35 to 38 per cent of five-year cures in breast cancer. The employment of radiation to date has not materially raised the percentage of five-year cures in the operable cases. The Memorial Hospital of New York has a five-year cure record of 39.5 per cent. This is by the combined use of preoperative irradiation cycle, the employment of a radical mastectomy, followed in about six weeks by a postoperative irradiation cycle.

The author deals with duct carcinoma under the headings scirrhous, medullary, diffuse duct, Paget's disease, inflammatory and anaplastic, and with adenocarcinoma under the subdivisions of cystadenocarcinoma, bulky adenocarcinoma, sweat gland, gelatinous and anaplastic.

The employment of radiation over a scirrhous cancer has very little obvious effect. It may slow up the process somewhat, but it never causes its disappearance, and scirrhous carcinoma should not be considered as a radiosensitive type. Irradiation is probably wise, but the disease progresses slowly in spite of it.

Medullary carcinoma, a cellular type, is radiosensitive, and very frequently complete disappearance of palpable tumors is seen. The author feels that this type should be heavily irradiated, not only in order to destroy the tumor cells but to produce fibrosis and lymphocytic infiltration, and thereby hold the tumor as a local process.

Irradiation of the diffuse duct carcinoma is not very effective. On the other hand, radiation employed over the axillary metastasis shows that the metastasis is markedly radiosensitive.

In general, Paget's disease of the nipple is radiosensitive, and the author has obtained complete disappearance and freedom from disease for a period of from two to three years in 3 instances of adenocarcinoma of the nipple.

Superficial irradiation by roentgen rays over the site of inflammatory carcinoma will cause complete regression of this tumor. However, most of the patients with this type of cancer die from distant metastases, particularly intraabdominal.

Anaplastic carcinoma is a particularly discouraging type—extremely radiosensitive on account of the character of the cells, but the end-results are bad.

Cystadenocarcinoma is not radiosensitive as a whole, though portions of it may be, but the major part of the growth is papillary in type.

Radiation should be sparingly administered in cases of bulky adenocarcinoma, as this is not a radiosensitive type, and heavy radiation over it easily causes a breaking-down of the tumor.

Sweat gland carcinoma is radioresistant. The author has no instances of complete disappearance of this tumor under irradiation.

Treatment of recurrences seems most effective when the recurrence is superficial and thoroughly accessible to radiation. One of the most impressive types of recurrence, and one which offers a brilliant result from radiation treatment, is the rather bulky sternal metastasis. From such a recurrence, treated by a radium pack of 12,000 mc-hr at a distance of 6 cm., not only complete regression and disappearance of the recurrence have been accomplished, but the patient has remained free of disease, in one instance for six years and in another for four years. It is very common to see complete disappearance of bulky axillary and supraclavicular metastases in the more cellular forms of carcinoma. However, these metastases recur with great frequency.—*J. D. Camp.*

Seisser, F. Aktuelle Frage der gynäkologischen Strahlentherapie. (Present-day questions in gynecological radiotherapy.) *Strahlentherapie*, 1930, *36*, 671–685.

Up to 1920 it was thought that radiotherapy should be used only in inoperable cases of gynecological cancer; but about that time statistics began to show that for cancer of the cervix, at least, radiotherapy was superior to the radical Wertheim operation. Clinicians were divided into those who advocated irradiation and those who advocated operation, but it has been found that both methods have their indications and

a combination of the two is often the best treatment. There was less difficulty in establishing roentgen castration as a treatment for myomas and metropathies, though there are authors who still advocate operation for these conditions too. But in spite of all objections and difficulties radiotherapy has developed into an important branch of gynecology.

The technique of the use of homogeneous roentgen irradiation and the filtered radiation of radioactive substances has been pretty well worked out. Radioactive substances give the shortest wave rays. Their average wave length is about 0.01 A. This corresponds theoretically to about 1000 volts in the roentgen tube and roentgen tubes have not as yet been constructed that will bear more than 250,000 volts. The more intense action of radioactive substances as compared with roentgen rays has been attributed to the short wave length but that is not true; on the contrary, with decreasing wave length it requires a larger dose to produce the same biological effect. Probably short wave rays do not act directly but by production of secondary rays, particularly Compton rays, which are considerably softer than the primary radiation and to a great extent independent of the primary wave length. In practical roentgen therapy not more than 180 kv. is generally used.

It will be impossible to compare roentgen results until constant methods of application and constant standards of measurement have been worked out. The author's clinic uses two kinds of radiation, a harder one filtered through 0.5 mm. zinc and 1 mm. aluminum and a softer one filtered through 5 mm. aluminum, the tension, strength of current, and focus-skin distance remaining the same. This is the only way to get exact values comparable with each other. There is a great deal of discussion as to methods and as to whether a single large dose should be given or a number of small ones. But the author thinks a standard technique with a measurable biological effect should be established first. A great advance in dosimetry was made by the introduction of the R-unit and this has been still further improved by the adoption of the International r-unit but unfortunately the physical effect measured by air ionization for different wave lengths does not by any means correspond to the biological effect in the organism.

Both radium and roentgen rays are needed in the gynecological hospital for they supplement but do not replace each other.

Very little is as yet known about the biological action of the rays. It is generally thought that the action of the rays is a direct action on the cells. The author discusses the different theories and concludes that the action is an indirect one through the vegetative nervous system, circulation and cells. This theory is in harmony with the carcinoma dose that has been determined empirically, for this dose is 100 per cent of an erythema dose, that is, the amount that produces distinct erythema with changes in the circulation in the skin.

In treatment the author uses operation and irradiation in operable cases: radium or roentgen irradiation followed by operation in six weeks or operation followed by roentgen irradiation, and in inoperable cases radium and roentgen irradiation combined. About 20 per cent of all cases are cured and about 50 per cent of operable cases. Cure means freedom from symptoms for five years. The tumor tissue that has already developed must be removed and the surrounding pelvis made unsuitable for its further development. For this purpose the tumor should be removed surgically or given about a double erythema dose and the surrounding pelvic tissue about a single erythema dose. There are differences in individual reaction however. A patient of seventy requires less than half the dose required by a woman of thirty. And there are other conditions which make individual differences, such as cachexia, pigmentation of the skin, condition of the blood, etc. These conditions should be carefully studied and their effect on dosage determined.

Carcinomas of the ovary react best to about 30–40 per cent of an erythema dose, which is the same as the dose used for simple castration. The results are not too good either with irradiation or operation.

Genital sarcomas react very well to relatively small doses of rays, but they recur. The richer the tumor tissue is in cells, the smaller the dose of rays required. For the present it is best to operate on operable cases.

Irradiation is also effective in myomas, metropathies, genital tuberculosis, many other gynecological inflammations, hemorrhages of different kinds, endocrine disturbances, amenorrhea and oligomenorrhea, dysmenorrhea, infantilism and hypersexuality. Irradiation is also useful for castration and in osteomalacia.

For most of these benign processes roentgen irradiation is preferable as they require diffuse distribution of small amounts of rays. Roentgen rays do not cause any unecessary local necroses. Roentgen castration, or more properly speaking, destruction of the follicles, only requires about a third of an erythema dose. The author does not advocate so-called temporary sterilization. It is uncertain and there is a possibility of injuring future children. Myomas and metropathies can be cured by permanent sterilization—except submucous myomas. Even large doses of roentgen rays do not have a direct effect on myomas, except for edematous softening which is undesirable; so it is best not to give more than 50 per cent of an erythema dose at the focus. Genital tuberculosis can generally be cured by long-continued weak irradiation. The author has not had much effect from weak irradiation of acute inflammations but has had excellent results in chronic inflammations. Often capacity for conception is restored and later operations avoided. In stimulant irradiation of the organs in the narrowest sense he uses 1/20 to 1/30 of an erythema dose, and irradiation of the ovary in this way cures 2/3 of the cases of amenorrhea, oligomenorrhea and dysmenorrhea, and irradiation of the spleen cures about 75 per cent of the cases of cessation of genital hemorrhage of different kinds. The results of stimulant irradiation of the ovary are about the same as those of Leriche's genital sympathectomy, which supports the theory that the primary action of the rays is on the nerves.—*Audrey G. Morgan.*

Forsdike Sidney. Radium in gynaecology. *Brit. M. J.*, Sept. 20, 1930, *2*, 468–471.

In this article the author prefaces his remarks regarding the use of radium in gynecology with several paragraphs on the inadequate knowledge of the radiologist as to the action of radium, the proper use of screens and the best method of dosage. He suggests that there be a supply of radium available for experimental purposes and establish whether the effect of the irradiation is on the cell or the stroma; determine if the gamma waves which have passed through screen-equivalents of platinum and lead have the same value, and lastly, if it is more advisable for radium to be applied continuously or in divided dosages. In regard to the latter suggestion the author quotes some experimental work done by Lazarus-Barlow on the time-quantity problem. The conclusions from this work were that the same arrangement of time and quantity produced very different effects when acting upon the three types of epithelial tissues—columnar epithelium, dry squamous and moist squamous epithelium. Maximum effects were produced upon the epithelial cells and minimum effects upon the associated tissues in the case of a columnar cell growth when the quantity of radium is relatively large and the time relatively small; whereas in a squamous cell growth the optimum effects are produced when the quantity of radium is small and the length of exposure relatively long.

Considering the benign gynecological conditions, the author recommends the use of radium in menopausal hemorrhages. In this condition he attempts to govern his dosage so as to convert the endometrium into connective tissue without the production of necrosis, believing that the changes in the endometrium are alone responsible for the cessation of hemorrhage, and that the ovaries remain unaffected. Very satisfactory results from this condition have been obtained in a series of 200 cases by 53 mg. of radium in a screen equivalent of 1.0 mm. of platinum placed in the uterus for twenty-four hours. The author believes that all fibroids should be excised, because while radium banishes hemorrhage and causes the tumor to shrink, it will not make the growth disappear and the danger of degenerative changes is still present.

The author divided his cases of cancer of the cervix into the following clinical groups: (1) operable cases in which the disease was limited to the cervix; (2) borderline cases in which the vagina and and parametrium were involved and the uterus tethered, and (3) inoperable cases of advanced disease. The technique of radium treatment is not given. To the writer the results were unsatisfactory for only 17 per cent of five year cures were effected in groups (1) and (2). In the former, 4, or 28 per cent, remained free while in the latter, 4, or 12 per cent, showed no evidence of disease. As a result of these figures the author is convinced that surgical treatment offers the patient a better chance of cure.—*F. K. Alexander.*

Healy, W. P. Variation in radiosensitivity of epidermoid carcinoma of the cervix uteri. *Radiology*, 1929, *13*, 323–325.

Since the publication of Broders' classification of epidermoid cancers into four histologic groups, a study of the histologic structure of all biopsy specimens at Memorial Hospital, New York, has been made, dividing them into three major groups, based upon the degree of anaplasia present in the cells and the relative amount of stroma present.

The first intensive study on this basis was made by Dr. Max Cutler, who reviewed the slides of 200 cases treated in 1922 and 1923. His study seemed to indicate that classification of epidermoid carcinoma of the cervix into three histologic grades, based upon the degree of anaplasia present, was a practical one. Also, it seemed to indicate that these three groups corresponded to three degrees of potential malignancy: Group 1, low; Group 2, medium; Group 3, high malignancy. Moreover, there seemed to be a corresponding variation in the degree of radiosensitivity of the different groups.

Group 1, made up of cells adult in character, highly differentiated with a tendency to hornification and the formation of pearls, was resistant to radiation.

Group 2 cases, the plexiform type in which the cells show moderate anaplasia, few or no squamous characters, partial loss of polarity, a plexiform arrangement of the cells, and moderate tendency to infiltration, are decidedly more radiosensitive than the cases in Group 1.

Group 3, in which there is an absence of squamous characters, comprises a diffuse infiltrative growth and complete loss of differentiation of cells. It is highly radiosensitive.

The percentage of cases in the different groups was: Groups 1 and 3, approximately 20 per cent each; Group 2, 60 per cent. It is thus seen that about four-fifths of the cases occur in Groups 2 and 3, which are or tend to be, radiosensitive. This no doubt helps to explain the favorable results obtained by radiation therapy in carcinoma of the cervix. It also aids in offering a solution for the marked improvement observed in some quite advanced cases and the poor result obtained at times in apparently favorable cases. It is evident that the more anaplastic the cellular structure of a tumor, the more malignant it will be, and, likewise, the more radiosensitive and the more favorable for radiation therapy.—*J. D. Camp.*

Bowing, Harry H. The immediate response observed in the treatment of cases of carcinoma of the cervix uteri with radium. *Surg. Clin. N. Am.*, Feb., 1930, *10*, 131–139.

In this paper the author reports satisfactory palliative results following the therapeutic application of radium to the field of primary carcinoma, supplemented by high voltage roentgen rays. He believes that divided dosages and an intensive method in the application of the radium rays are desirable in the treatment of this disease; and further, it is essential to know what factors in the treatment to employ at the initial applications as well as in the subsequent courses which will produce the desired result. A satisfactory report following treatment usually contains statements regarding diminution of the amount of vaginal discharge and any change in its character. The bleeding and odor will disappear, and, in many instances, the distressing backache and unilateral pains in the leg will be greatly ameliorated and may cease entirely following the initial applications.

When the general response is satisfactory the local response is also gratifying. The bulky, medullary cervical carcinomas gradually diminish in size, lose the typical gross appearance of a malignant lesion, and ulceration and necrosis are not noted as effects of treatment. The bulky, fixed infiltrations which occur at the primary site, in the vaginal walls, and in the regions of the broad ligament will diminish in size.

The patients are hospitalized for twenty-four hours before the radium is applied and surgical technique is used in placing the radium, the patients being placed in the knee-chest position. The field of treatment is prepared by douches followed by antiseptic solutions to the vaginal walls and the malignant area. Every care is taken to avoid unnecessary trauma to the cervical infiltration.

All applications of radium except the intrauterine treatments were made with the universal monel tube applicator, with a wall thickness of 1.5 mm. and containing 50 mg. of radium. Monel tubes containing 5 mg. of radium were buried in the infiltrated area from 1 to 2 cm. apart. In addition to the above, a tandem applicator with provision for filtration through 0.5 mm. of silver and 1 mm. of brass was used for intrauterine application. With this method of treatment, in the cases cited for illustration, from 5106 milligram-hours and millicurie-hours to 8440 mg-hr. and mc-hr. were given in nine to eleven applications. The radium treatments

were followed by the application of high voltage roentgen rays. The following factors were employed: 200 kv., 5 ma., distance, 50 cm; filtration through 0.75 mm. Cu and 2.0 mm. Al; time, one and one-fourth hours to each of four areas, anterior, posterior, and two lateral fields. One area each day was treated until all had been exposed.

The 3 cases reported by the author were not selected on account of what may be considered an unusually good response to treatment; instead, they must be considered as cases which have responded satisfactorily to treatment and as representing the average result obtained by the intensive method of treating cases of carcinoma of the cervix with broken doses of radium and roentgen rays.—*F. K. Alexander.*

Dautwitz, Fritz. Spatschädigung der Frucht durch indirekte Radiumstrahlenwirkung? (Does indirect radium irradiation cause late injury of the fetus?) *Strahlentherapie*, 1930, *36*, 686–707.

There is considerable evidence that the child may be injured by direct irradiation of the uterus during pregnancy but there are also reports that it may be injured by indirect irradiation of other parts of the body. The author describes a case in point. The patient was a woman of thirty-four who was first irradiated for inoperable angiosarcoma of the thyroid on March 9, 1926. She gave birth to a girl on Aug. 9. Delivery was normal and the child was well on discharge from the hospital. The patient had been given a second series of irradiations in July. In March, 1927, she was given a third series. In April she had her last period. The second child, a boy, was born on Jan. 23, 1928. In June of that year the patient reported that her condition was greatly improved and the boy was well and strong, but that the girl was not in good health and could not walk well. In the late summer she began to have spasms of the legs and then of the arms and finally of deglutition, and died. Autopsy showed that she died of sclerosis of the brain. The boy was still unusually well and strong.

This patient from March 9, 1926, to the end of April, 1929, was given 7 series of irradiations amounting to 45,857 milligram-hours radium distributed over the throat and thorax; 9,823 mg-hr. were given during the second half of the first pregnancy; 8,216 mg-hr. were given during the second pregnancy, 4,816 during the first half and 3,400 in the second. The second child therefore was subjected to a lower dosage of rays distributed over a longer period. The objection might be made that the defect in the first child was constitutional and not caused by the rays but the symptoms were just the same as those seen in children who have been injured by direct irradiation. The second child seems unusually well and strong at present but it is impossible to say whether he will show injury later.

In view of the possible injury of the offspring a woman should not be irradiated during pregnancy if it is possible to avoid it; but in case of inoperable carcinoma when failure to irradiate would mean death of the mother and probably also of the child and when treatment would come too late if it were deferred until the child was viable the author thinks irradiation is justifiable.—*Audrey G. Morgan.*

Martius, Heinrich. Röntgenstrahlen und Keimschädigung. (Roentgen rays and injury of the embryo.) *Strahlentherapie*, 1930, *37*, 164–176.

It is quite generally acknowledged that irradiation during pregnancy injures the fetus but there is considerable discussion as to whether the offspring may be injured by irradiation of the ovaries at any time. The author irradiated white mice before conception with 145 r. Of the 5 mice irradiated, one did not conceive and the others only had an average of five young, which is only 50 per cent normal. Half of these died within a short time and the others were underweight and had thin, coarse hair and remained sterile. Mutations of the genes have been produced by irradiation of Drosophila. While it is possible that experiments on plants and animals do not justify conclusions in regard to man, the author believes that irradiation may cause gene mutations in man which give rise to new recessive pathological hereditary factors which will become manifest in the descendants when paired with the same recessive anlage. Until this is disproved he does not believe the ovaries of women should be irradiated during the period of sexual activity. He thinks there may be some danger even in the use of irradiation for diagnostic purposes and particularly condemns repeated irradiations during labor to follow its course.—*Audrey G. Morgan.*

Duncker, Hans. Röntgenstrahlen und Keimschädigung. (Roentgen rays and injury of the embryo.) *Strahlentherapie*, 1930, *37*, 142–163.

The author describes experiments in irradiating Drosophila for the purpose of determining the effect of roentgen rays on the germ. He found that when roentgen irradiation is given in certain doses at a certain time in mitosis it causes a disturbance of the mechanism of distribution of the chromosomes or rupture of the chromosomes. It is possible that these changes are caused by depolarization or change of polarization of whole chromosomes or parts of chromosomes. They cannot be considered true mutations of genes. Roentgen irradiation may also cause a loss of atoms which leads to a change in the catalytic action of the genes. These are true gene mutations. Both processes lead to changes which are mostly in the direction of degeneration. The degenerative action of irradiation increases with increasing dosage.

Patterson irradiated tissue that was still capable of division and found that changes could be produced in this way on circumscribed areas of the body as those produced in the whole body by irradiating the germ cells. There is no essential difference therefore in the action of the action of the rays on germ cells and soma cells. Disturbance of the distribution of chromosomes, rupture of chromosomes or gene mutations are always produced and affect the descendants of the irradiated cells.—*Audrey G. Morgan.*

Knuthsen, L. F. R., and Humphris, F. Howard. Pruritus ani et vulvae. *Lancet*, Sept. 13, 1930, *2*, 569–572.

In this paper the authors carefully enumerate the etiology and symptomatology of these conditions, primarily from a dermatological standpoint. The various applications are given.

They state that roentgen treatment of pruritus continues to be a success, especially in cases of long standing. The rays are directed into the anal region, perineum, and, in woman, to the vulvae. A special stool is used which is placed over the roentgen tube. In males the testicles are protected by a sheet of lead on the seat. The best results have been obtained with fairly soft rays given in divided doses. The authors use a spark gap of 5 to 6 inches unfiltered, for the first three treatments, and for the last three a filter of 1 mm. of aluminum. Six doses of 1/6 B (beta) are given, either daily or over a period of ten days, depending on the severity of the case.—*F. K. Alexander.*

Schreiner, Bernard F. Treatment of epithelioma of the penis based on a study of sixty cases. *Radiology*, 1929, *13*, 353–361.

Schreiner classified his cases in two groups, Group I, in which the lesion was confined to the penis, and Group II, having the lesion on the penis, with definite metastases in the lymph-bearing areas of the groins. These classifications were made clinically at the time of admission, including in Group II all cases in which the lymph nodes were palpable and were thought to be metastatic. If subsequent operation proved that they were not metastatic, they were put in Group I. Dividing these case records in this way, for study, 23 cases are classified as Group I and 37 as Group II.

In Group I, unfiltered roentgen radiation alone has cured epithelioma of the penis in two instances, for ten years and for eight and one-half years. One case treated by implantation of the lesion with radium and high voltage roentgen rays over the groins is well, three and one-half years later. Unfiltered roentgen treatment of the local lesion, with high voltage roentgen rays over the groins, together with partial operation, has resulted in healings, 2 for seven years, one for ten months, and 2 for eight months. Of the 11 cases in which radical operation and radiation were combined, 6 are living (for eleven years, seven years, five years, three years, one year and one year respectively); 3 died from operation; one died six years after from an other cause; one died of internal metastasis in two years.

In Group II unfiltered roentgen rays or implantation of radium in the primary lesion, together with high voltage roentgen rays over the groins, has resulted in healing or great improvement in the primary lesion, but as a rule the patients have died from metastases. The implantation of radium into the lesion, with removal of metastatic nodes and implantation of the groin, has resulted in healing in one case for five years. Radical operation and thorough irradiation was performed eight times, resulting in only one clinical cure (for thirteen and one-half years); the other 7 patients lived only from two months to one and one-half years.—*J. D. Camp.*

Brummer, K. Über einen Fall gleichartiger Wirkung von ultra-violetten und Röntgenstrahlen. (A case of the same effect produced by ultraviolet and roentgen rays.) *Strahlentherapie*, 1930, *36*, 716–720.

The theory that only ultraviolet rays have a specific action and the shorter wave roentgen and radium rays a nonspecific action is evidently not true. This theory was based on the fact that the energy content of roentgen and radium rays is enormously greater than that of ultraviolet rays but biological processes are complicated and do not run parallel to the energy content.

In irradiating ergosterin it was found that the antirachitic action of ultraviolet rays is not limited to a very narrow spectral region (it was originally assumed to be limited to the region between 3130 and 2900 A) but that it extends much farther than that in both the long and short wave directions. In April, 1929 Delaplace and Rebière reported before the Paris Academy on spectroscopic findings in ergosterin solutions; they found similar spectral absorptions in ergosterin irradiated with ultraviolet and soft roentgen light.

The author performed experiments to determine the effect of ergosterin irradiated with soft roentgen rays. White rats were made rachitic by being given a vitamin-free diet. After twenty-one days on the diet they were examined roentgenologically; the majority of them were rachitic and only these were used. They were then given a diet containing ergosterin activated by irradiation with soft roentgen rays. Animals fed with equal amounts of non-irradiated ergosterin were used as controls. After three weeks' feeding the animals that had been fed with ergosterol activated with roentgen rays did not show a trace of rickets and had increased 20–30 gm. in weight. The control animals showed very severe signs of rickets and two of them died.

These experiments show that soft roentgen rays as well as ultraviolet rays change ergosterin into antirachitic provitamin.—*Audrey G. Morgan.*

Cremer, Max. Röntgenkatarakt, deren Bedeutung und Verhutung. (Roentgen cataract and its prevention.) *Strahlentherapie*, 1930, *36*, 732–735.

The first reports of opacities of the lens after roentgen irradiation were made by Guttmann and Treutler in 1905. They were in individuals who worked professionally with roentgen rays. The author himself has seen a number of cataracts that were beyond doubt caused by roentgen rays. Reports vary as to the amount of rays that can be borne by the eye without injury. A number of authors say that 100 per cent of an erythema dose is well borne. Ophthalmological examinations should be made on this point by means of the slit lamp with the pupils dilated with atropin after roentgen and radium treatment and the results assembled to determine the dosage that is safe. Results on animals cannot be applied to man. A case is reported in which the dose to be used was tested in animal experiment to prove that it was harmless. But when it was applied to a child's eye it not only caused an inflammation of the cornea but also a cataract, which was so far advanced in nine months that it had to be extracted. So there is no doubt that steps should be taken to protect the eyes in radiotherapy and the roentgenologist is legally responsible if he damages them. The author has had a gold shell made for protection. Gold 1.3 mm. thick gives as much protection as 2 mm. lead; 0.75 mm. gold gives sufficient protection. The shell has a very thin glass covering on its inner surface. It is so constructed that it does not rest on the cornea but on the sclera. First 2 drops 2 per cent cocaine-adrenalin and two minutes later 2 drops 5 per cent cocaine solution are instilled into the conjunctival sac; after one minute the prosthesis can be put in. The author has used this method in 29 cases; he has left the shell in in some cases as long as an hour and a half and examination with the corneal microscope has not shown any injury. Some of the cases have been under observation for two to three years and no roentgen cataract has developed in any case.—*Audrey G. Morgan.*

Martin, Hayes E. Factors in dosage determination in interstitial radiation. *Radiology*, 1929, *13*, 338–344.

The determining factor in successful radiation therapy is the production of a lethal tissue dose in all parts of a neoplastic volume of tissue. The dosage in interstitial radiation is empirical and depends on the proper evaluation of numerous factors always present in different combinations in a given case. A list of the most important factors to be considered in the estimation of interstitial dosage includes: (1) size of the

lesion, (2) shape and contour of the lesion, (3) radiosensitivity of the neoplasm, (4) tolerance of the adjacent normal tissue and the effect on the whole organism of a lessened function of this tissue, (5) tolerance of the organism as a whole, (6) variation in the physical characteristics of the implants, such as their number, position, filtration and strength, and (7) previous irradiation or intended external irradiation. —*J. D. Camp.*

Coutard, H. Zusammenfassung der Grundlagen der röntgentherapeutischen Technik der tiefgelegenen Krebse. (Principles of roentgen therapeutic technique in deep cancer.) *Strahlentherapie*, 1930, *37*, 50–58.

The author summarizes the technique of the treatment which he has used for the past ten years as follows: The irradiation should be as rich as possible in short wave rays which necessitates 180 kv. and 2 mm. zinc filter. In cancers of the larynx, pharynx and tonsils the focus-skin distance varies from 50 to 60 cm. In deeper cancers, such as those of the cervix it varies from 80 to 100 cm. The size of the fields of course varies. In carcinomas of the larynx two symmetrical fields 50 sq. cm. in area are often enough; in carcinomas of the hypopharynx with enlarged glands, two symmetrical fields of 150 to 200 sq. cm. may be necessary. General symptoms may be caused by irradiating a field 75 to 100 sq. cm. in area at the neck, while in other regions 300 to 400 sq. cm. may be irradiated without causing symptoms. The irradiation of a large field increases the danger not only on account of the general reaction but on account of the greater severity of the skin lesions, so the author now lengthens the time required for the daily dose, giving in 30 to 40 hours the irradiation that was formerly given in 15 to 20. Radiodermatitis and radioepithelitis are tests of the effect of the irradiation on the skin and on the epithelial tumors. A deep dose of 35 H produces a normal radioepithelitis on the mucous membrane, while a dose of 45–50 H is necessary to produce a radioepidermatitis. The intensity per hour required to produce a radioepidermatitis is much less than that required to produce an erythema. The erythema method is an intense method while in the author's quantity method the irradiation acts selectively on the epidermis cells and destroys them, while the blood and lymph capillaries are not affected. Erythema and edema are not caused. The method has given good results in tumors of the pharynx, larynx and tonsils.—*Audrey G. Morgan.*

Miescher, G. Gegenwärtige Methoden der Krebsbestrahlung und ihre Erfolge. I. Einmalige Hochstdosis. (Present methods of cancer treatment and their results. I. The single large dose.) *Strahlentherapie*, 1930, *37*, 17–30.

The author has been using intense irradiation of skin carcinoma with a single large dose for twelve years, and discusses his results. The average dose was 1200 to 1500 R on the surface of the water phantom with a field 4×4 measured with a Siemens dosimeter with a chamber independent of wave length and direction. Tables are given showing the details of the results. They were very good, somewhat better in basal cell carcinomas than in horny pearl cancers. Primary recovery, that is, without recurrence was 89 per cent in the former group and 75 per cent in the latter. Counting the cases that recovered after another irradiation or operation the figures were 94.5 and 80.5 per cent. The results show that it is not necessary to use exclusively hard or exclusively soft rays or to precede the irradiation by excochleation, as some authors claim. In the author's cases the hardness of the rays was determined solely by the depth of the carcinoma. Superficial carcinomas were irradiated under a filter of 0.5 to 1 mm. aluminum, deep ones under a zinc filter. Comparison with the figures of Schreus who used a smaller dose shows that the larger dose is better. Comparison with the results of the Radiumhemmet in Stockholm shows that the method gives as good results as radium treatment.

A grouping of the results according to the kind of cancer treated shows that almost all the failures were in carcinoma terebrans. The same dose was used as in the other cases so these carcinomas must have a greater resistance to the rays than other forms. But as a dose of 1500 R is quite a heavy one for a skin already injured by a chronic ulcerative process it is not advisable to give any larger dose. For the past two years the author has been having good results, particularly in carcinoma terebrans, with the method of daily divided doses introduced by Coutard and discussed elsewhere in this journal by Schinz (see following abstract).

As a general rule the single large dose cannot be used in carcinoma of internal organs. It

may be used in small carcinomas of the mouth but for extensive carcinomas of the mouth or those of the deeper organs, it is difficult to give the necessary carcinoma dose without injuring the tissues. Moreover, carcinomas of the internal organs are rarely discovered and submitted to treatment in the early stages when they are most sensitive to rays. So in deep carcinomas and carcinoma terebrans of the skin divided doses should be used.—*Audrey G. Morgan.*

Schinz, Hans R. Gegenwärtige Methoden der Krebsbestrahlung und ihre Erfolge. II. Verteilte Dosis. (Present methods of cancer treatment and their results. II. Divided dose.) *Strahlentherapie*, 1930, *37*, 31–49.

Miescher has shown what can be accomplished by a single large dose in the treatment of carcinoma of the skin and lips. He had excellent results by giving twice the erythema dose. But with a large field this method is dangerous as it causes too severe a skin reaction. Not much has been accomplished with it in cancers of the tongue, tonsils and hypopharynx nor are extensive and infiltrating carcinoma terebrans of the skin or infiltrating prickle cell carcinoma cured by it. But protracted fractional roentgen irradiation makes it possible to give a very large total dose without severe injury to the skin. The carcinomatous region is irradiated daily or twice a day from one or more fields with 1/3 of a skin unit dose, the amount of irradiation per unit of time being very small. This is accomplished by filtering through 1, 2 or 3 mm. copper with a focus-skin distance of 60–100 cm. The daily duration of irradiation per field is one or two hours, while with the technique previously in use it only required a few minutes to give the same dose. The number of fields and their size and shape of course varies with the size and shape of the tumor and whether or not there are regional gland metastases. Coutard, who originated the method, measures his dosage in Holzknecht units and gives 2 to 4 H in one to two hours. The daily irradiations are continued until a total dose of 50 to 150 H has been given. This means a total dose of 5 S.U.D. and a total duration of irradiation of fifteen to thirty hours or more. With this technique the focal dose is always several times the skin unit dose. The total treatment covers about four weeks.

The skin reaction is not an ordinary roentgen erythema. The French call it a radioepidermitis. There is a dry and an exudative form. There is also a radiomucositis. About twelve to fifteen days after the beginning of the irradiation there is quite a severe mucous membrane reaction. This is generally accompanied by rather severe subjective symptoms and difficulty in swallowing. Radioepidermitis and radiomucositis are a test of whether the treatment has been properly carried out or not. Without these reactions it seems impossible to cure carcinoma of the mouth, larynx and pharynx.

Most of the cases in which the author has used the method have been inoperable so the results are not very good so far as statistics are concerned. But the severity of the cases should be taken into consideration and the fact that carcinomas of the larynx may be rendered operable by this method.

His material for the past year included 7 cases of carcinoma of the tonsils. The tumor disappeared in 3; one of these patients is living free of symptoms, one is living with a metastasis and one died free of symptoms. In 3 cases the tumors did not disappear entirely, there were recurrences and the patients died. One patient died six days after the beginning of treatment of an aspiration pneumonia. There were 6 cases of carcinoma of the tongue, one of which had been treated unsuccessfully with radium. Protracted fractional irradiation was only given in the gland region as a palliative measure for a short time. Of the other 5, two hopeless cases treated with two small doses of 700 and 750 per cent of a skin unit dose were not affected. Two cases were freed of local symptoms. One of these patients is living and the other had a recurrence after eight months. The other patient was relieved of symptoms but had a small residual tumor for which he refused further treatment. He had a recurrence and died. Among the 14 cases of carcinoma of the hypopharynx only 2 are free of symptoms after 9½ and 11 months but 11 of the 14 cases were completely relieved of symptoms at first. The patients died of metastases outside the irradiated region. Among the 4 cases of internal carcinoma of the larynx the tumor disappeared in 3; in one of these, however, too small a beginning dose was given and there was recurrence. The fourth patient was given too small a dose and was not affected.

The method of protracted fractional irradiation is to be recommended in suitable cases.—*Audrey G. Morgan.*

Fitzwilliams, Duncan C. L. The technique of radium therapy to-day. *Brit. M. J.*, Aug. 30, 1930, *2*, 309–311.

The author gives a brief résumé of the physics of radium treatment, its effect upon normal and malignant tissue and a description of the forms of treatment employed. Dosage, results and limitations of treatment are discussed in general. A plea is made for better schooling in the principles of radium therapy.—*G. R. Miller.*

Souttar, H. S. The use of radon seeds in the treatment of carcinoma. *Brit. M. J.*, Aug. 23, 1930, *2*, 273–279.

Radon seeds show certain advantages in the treatment of malignancy. A large amount of energy can be concentrated in a small space, the seeds can be placed in desirable locations and the danger of infection is slight, especially when numerous seeds can be deposited through one puncture with the aid of a detachable magazine devised by the author. Mucous membrane and skin can be spared from severe reaction by the use of platinum filter for those seeds which are to be placed near the surface. In general, 1 mc. will suffice for 1 c.c. of tissue, but correct distribution of seeds enables the irradiation of a considerable volume uniformly with a surprisingly small amount of radon by virtue of cross-fire effect.

The tongue is a favorable site for radon implantation. The growing edge of the lesion should be the region attacked rather than the center. Frequently the mistake is made of concentrating on the center of the tumor. There results merely a local necrosis with little if any effect upon the advancing portion. Approach may be either directly through the tongue or through the floor of the mouth for deep lesions. Seeds are also deposited around the cervical lymph glands.

Breast lesions are surrounded with seeds. The cannula is also introduced along the axillary vein by a puncture wound in the axilla and seeds deposited along the subclavian region. Another chain of seeds is placed along the serratus magnus and the axillary border of the serratus magnus. One seed is deposited in each intercostal space just outside the sternum and two in the sheath of the rectus. Very large tumors must be treated in divided doses to avoid the systemic effects of too much irradiation.

Esophageal carcinomata respond well to the implantation of radon. The seeds are deposited through an esophagoscope, and although no guarantee can be given that the wall of the esophagus will not be punctured by the cannula there is little danger of infection because of the presence of the radon seed. The method is safer than the passage of a bougie. Results are palliative but worthy of trial.

Rectal lesions, particularly those within reach of the finger, can be treated by the implantation of two rows of seeds posterior to the rectum through two perineal punctures. The position of the point of the cannula can be determined by the finger within the rectum. Lesions at a higher level must be treated through a laparotomy. Inasmuch as there is difficulty in destroying all of the malignancy in rectal carcinomata it is advisable to follow irradiation by excision. Not infrequently inoperable cases are made operable by the radon.

During the last two years radon seeds have been employed in this clinic whenever possible to the exclusion of other methods. Although the time is too short to give conclusive data it is evident from a review of 85 cases that the method is a promising one.—*G. R. Miller.*

Russ, S., and Clephan, Dorothy F. Distribution of radiation from clinical radium tubes. *Lancet*, Aug. 9, 1930, *2*, 286–289.

Auto-photographs of radium tubes and needles used in clinical work show that the distribution of the salt in them is not always uniform. Ionization measurements of different sections of tubes corroborate the photographic findings.

Purchasers of radium may find it necessary to insist upon guarantees relating to the distribution of radium in tubes.—*G. R. Miller.*

Carling, Francis Rock. Latest modification of Westminster teletherapy apparatus. *Brit. M. J.* July 19, 1930, *2*, 99–100.

Four grams of radium is contained in a lead bomb 5 inches thick. There are portals above and below for the emergence of rays. In the line of these rays are stretchers. A convenient arrangement of tilting devices of both bomb and stretchers permits any part of the body of the patient to be irradiated from any angle. The bomb is so directed that it never directs the radiation at the occupied portion of the building. The controls are at a safe distance and 24 inch walls of the room contain barium plaster.—*G. R. Miller.*

MISCELLANEOUS

Fling, H. T., and Grimmett, L. G. Measurement of the distribution of gamma rays around a four-gram mass of radium. *Brit. M. J.*, July 19, 1930, *2*, 98–99.

At the Westminster Hospital Annex 4 grams of radium is contained in a lead "bomb" so constructed that rays emerge only through two openings, one above and one below. With an ionization chamber the gamma-ray isometrics were determined for a portal 16 cm. in diameter to a depth of about 22 cm. in air. The intensity decreased from 100 per cent to 15 per cent in about 22 cm. The distance of the 100 per cent line from the radium was not stated.—*G. R. Miller.*

Cairns, Hugh, and Fulton, J. F. Experimental observations on the action of radon on the spinal cord. *Lancet*, July 5, 1930, *2*, 16.

Radon seeds 1.5 cm. long and screened by 0.3 mm. of platinum were placed alongside the spinal cords of cats and monkeys. The position was extradural on the dorsal surface of the lower dorsal region. Observations of neurological signs indicated the time and extent of injurious effects upon the cells.

The results are shown in the following table:

C. D. (M)	W. K. (d)	Pp	C. D. (M)	W. K. (d)	Pp
	Cats			Cats	
31.3	1+	Comp.	6.6	6	Slight
28.3	2	Comp.	6.3	6–8	Slight
27.0	2	Comp.	3.7	None	None
24.7	4	Comp.	3.1	None	None
16.2	2–3	Comp.	2.8	None	None
16.3	4	Comp.	0.0	None	None
10.0	5	Comp.		None	
9.8	5	Comp.		Monkeys	
9.2	5	Incomp.	11.8	3	Slight
9.0	4	Incomp.	9.0	None	None
7.3	8	Slight	6.1	None	None

C. D. (M) = Corrected dose (millicuries)
W. K. (d) = Appearance of weakness (days)
Pp = Paraplegia (complete; incomplete)

—*G. R. Miller.*

Heim de Balsac, F., Agasse-Lafont, E., and Feil, A. Préparation et manipulation des corps radio-actifs; risques pathologiques professionnels, mesures prophylactiques et résultats. (Preparation and manipulation of radioactive bodies; professional pathological risks, prophylactic measures and results.) *Presse méd.*, Aug. 30, 1930, *38*, 1171–1173.

The authors undertook two investigations for the determination of professional injuries produced by radioactive substances. The first investigation was carried out in a factory where monazite, a mineral imported from Brazil, was worked over for the extraction of mesothorium. The various salts obtained in connection with this procedure were: (*a*) cerium salts, utilized in the glass industry, in research and therapeutic laboratories; (*b*) salts of rare earths which likewise are used for therapeutic purposes; (*c*) thorium nitrate, used for the manufacture of incandescent bulbs, and (*d*) mesothorium, used especially as a radioactive substance.

As is known, the professional injuries resulting from handling the above substances may be the result of actual contact (radiodermatitis) or of inhalation of the emanation produced by mesothorium (anemia, leucemia, etc.). Four subjects were examined (2 chemists and 2 laborers) all of whom had spent from one to one and a half years in the above factory. In none of them was there the slightest trace of injury or pathological disturbance.

The second investigation was carried out in a scientific laboratory where radioactive substances were handled: preparation of radium and mesothorium salts, transformation of the sulfate of radium or of mesothorium into bromide or chloride salts, separation of mesothorium from radiothorium, and finally preparation of thorium X.

Here the professional injuries may be the result of the penetrating rays acting at a distance (anemia, etc.) or of inhalation of the emanations or finally, due to actual contact (radiodermatitis). It must be mentioned that in the place investigated all precautionary measures were strictly observed.

Three cases were examined, one of them being in actual service for a period of two years, the second for a period of eight, and the third for a period of sixteen years. In none of the cases was there any evidence of injurious effect.

The conclusion is reached that the number of workers employed for the handling of radioactive substances in France is as yet very small and that due to the strict prophylactic measures no injuries have occurred from this professional occupation.—*T. Leucutia.*

D'Halluin, Maurice. Cancer, glycémie expérimentale, radiations. (Cancer, experimental glycemia, radiations.) *Bull. et mém. Soc. de radiol. méd. de France*, June, 1930, *18*, 249–263.

Slosse and Reding have studied the effect of the roentgen rays on the modification of pH, as well as on the calcium and glucose metabolism and found that cancer patients as a rule present an alkalosis, a diminution of ionized calcium and disorders of glycemia. These latter appear following the ingestion of 50 gm. of glucose in the morning (on an empty stomach) and consist in an increase of the blood sugar as a whole, the peak being reached within one hour (instead of thirty minutes as in healthy subjects) and the elimination lasting for nearly two hours. With healing of the cancer the humoral modifications return to normal.

The author in rechecking the above findings has paid special attention to the modifications of the sugar metabolism. In 29 patients with cancer a normal blood sugar was found in 75.8 per cent. Following ingestion of 50 gm. of glucose in 200 c.c. of water there was an elevation of the blood sugar above that of non-cancerous patients in nearly all these cases, the average elevation amounting to 0.741 gm. per liter of blood. A delayed elimination was observed in 48 per cent of the cases. As soon as the cancer (as a result of treatment) disappeared the values returned to normal.

Thus the artificial provocation of the hyperglycemia can be used advantageously for the estimation of the humoral modifications during the course of the irradiation. A return to normal indicates a favorable prognosis.

The close relation between the humoral changes of the system and the state of the cancer suggests that a reëstablishment of normal humoral balance must form one of the chief aims during radiation therapy. With the collaboration of M. Paget the author is now working on such a procedure. The first results have been rather encouraging. Further studies are, however, necessary before arriving at final conclusions.—*T. Leucutia.*

Piffault and Barreau. Au sujet de cancer. Glycémie expérimentale. Radiations. (On the subject of cancer; experimental glycemia; radiations.) *Bull. et mém. Soc. de radiol. méd. de France*, July, 1930, *18*, 288–289.

In connection with the communication of d'Halluin (see above abstract), the authors briefly present their observations gathered in collaboration with Danulesco and Enachesco during the studies of the serum abnormalities of cancerous patients.

The reaction of Botelho, using the modifications of Mme. Tedescho-Polak, was employed as the basis of experimentation. Only those cases which following the addition of Botelho's reagent showed a flocculation of the serum (in a hemolytic tube) sufficiently opaque as to obstruct the view of the filaments of an incandescent light were taken as positive. The material included the serum of 90 cancerous patients, all verified histologically, and of 90 non-cancerous patients. The reaction was positive in 73.4 per cent of the cancerous and in only 14.5 per cent of the non-cancerous patients. In 5 doubtful cases the positive reaction directed the attention toward the possibility of cancer, this being later microscopically verified.

Botelho made the observation that the reaction may appear positive in normal subjects after preliminary hyperalkalinization or dilution of the serum. This was confirmed also by the authors.

Of 23 cases of cancer submitted to treatment, in 21 the reaction was positive previous to the treatment and in only 6 (five days) following the treatment. The authors wish to state, however, that they are not prepared as yet to draw prognostic indications from these data.—*T. Leucutia.*

Belot, J. Ampoule Coolidge fonctionnant à 400,000 volts sous tension constante. (Coolidge tube functioning at 400,000 volts constant tension.) *Bull. et mém. Soc. de radiol. méd. de France*, June, 1930, *18*, 267–270.

Gaiffe-Gallot and Pilon have recently constructed a new tube for deep roentgen therapy which can be operated at 2 ma. and 400,000 volts constant tension. The construction of this tube was possible through improvement in the process of extraction of the gas, the residual pressure now being 1/100 of a millionth of a millimeter of mercury, which means that only one-thousandth part of the molecules of gas of the old tubes is present.

The tube is air cooled and a few centimeters longer than the 300,000 volt tube. Its bulb measures 200 mm. in diameter and there is a slight variation in the relative position of the electrodes. The cathode is constructed of a

metallic mass from which the gas was extracted by special means.

It was found that four or five times greater thickness of lead is necessary to protect against the rays emitted by a 400,000 volt tube than for the rays emitted by a 200,000 volt tube. Thus, the tube which is functioning at the manufacturer's experimental laboratory under the supervision of Professor Perrin was inclosed in a lead box, the walls of which vary from 6 to 10 cm. in thickness.

The roentgen-ray output of this new tube is considerably greater. An erythema is obtained at twice the distance when the tension is increased from 200,000 to 400,000 volts. This naturally results in a greater depth dose.—*T. Leucutia.*

Solomon. Appareil de contrôle ionométrique. (Apparatus for ionometric control.) *Bull. et mém. Soc. de radiol. méd. de France*, June, 1930, *18*, 244–246.

It is absolutely necessary that the constancy of an ionometer be checked from time to time. Two methods may be utilized for this purpose: (*a*) a restandardization with a known quantity of radium, and (*b*) the estimation of a certain ionization discharge.

The restandardization by comparison with certain radioactive substances is no doubt the better of the two methods. However since it requires minute technical precautions it is rarely applied in practice.

The author has worked out a new procedure based on the principle of the second method. It must be stated, however, that this procedure can be used only for restandardization, that is, a "secondary" standardization of an ionometer, and not for the first or "primary" standardization, which must always be done by the use of a radioactive substance.

The principle of the author's procedure is as follows: If one employs two electrically insulated metallic disks 1 cm. apart and covers one of the disks with a layer of black uranium oxide, the alpha particles emitted by the uranium ionize the air between the two disks, thus leading to a difference of potential sufficient to produce an electric current. This current under potential of saturation will depend exclusively on the surface of the uranium oxide, the number of the alpha particles being absolutely constant. Under such circumstances the two disks can be used as a standard ionization chamber for a check of any ionometer. If on two occasions a difference in the time of discharge is obtained (by the intercalation of the disks), this can be attributed only to a modification in the capacity of the apparatus, indicating that the constancy of the ionometer has changed.

For ionometers of the order of from 500 to 1000 R the author employs disks of 10 cm. in diameter, the time of discharge amounting to from two to four hours.—*T. Leucutia.*

Surmont, H., Surmont, J., and Tiprez, J. Présentation d'un appareil permettant la stéréoradiographie horizontale. (Presentation of an apparatus permitting horizontal stereoroentgenography.) *Bull. et mém. Soc. de radiol. méd. de France*, June, 1930, *18*, 270–273.

The authors have made certain changes in the apparatus of Dioclès so as to fit it for horizontal stereoroentgenography. The table and the changes brought about are described in detail. It is the authors' contention that horizontal stereoroentgenography is of advantage in conjunction with vertical stereoroentgenography.—*T. Leucutia.*

Goldstein, M. J., and Neworoschkin, J. P. Über die Veränderungen der Katalase und Lipase im Blut der mit Röntgenstrahlen behandleten Kranken. (Changes in the catalase and lipase content of the blood of patients treated with roentgen rays.) *Strahlentherapie*, 1930, *36*, 736–744.

Most of the functions of the organism are caused by the presence of ferments in the tissues and organs. Very little work has been done on the effect of short wave rays on fermentative processes in vivo. The authors therefore studied the effects on catalase and lipase of deep roentgen irradiation. They irradiated and examined 18 patients. The protocols are given. They found that under the influence of local irradiation of the lymphatic glands, thyroid and spinal cord the catalase content of the blood increased. The greatest increase of lipase was brought about by irradiation of the lymphatic glands. The catalase content was increased 1 1/2 times or more in twenty-four hours in patients with lymphosarcoma of the neck, lymphogranulomatosis and carcinoma metastases in the axillary glands after amputation of the breast. In these cases the dosage was 3–4 H. There was no special catalase curve for the different diseases

nor did the curve change uniformly with the improvement of the disease. The change in the catalase curve was about the same no matter whether the condition was improved or not. The catalase curve returned to normal eight days after the irradiation.

In lymphogranulomatosis, carcinoma metastases and sarcoma of the neck the lipase index was decreased; it increased after the first irradiation, remained at this level for eight days and rose still higher after succeeding irradiations. In Basedow's disease and hyperthyroidism there was an increased lipase content in the blood before irradiation. After the first irradiation it fell to normal and remained so until the end of the observation. There was a slight increase of lipase in tuberculosis patients after irradiation. In all other cases the lipase content was not changed.—*Audrey G. Morgan.*

Johnson, Clayton R. Stereoroentgenometry; a method for mensuration by means of the roentgen ray. *Am. J. Surg.*, Jan., 1930, *8*, 151–163.

Stereoroentgenometry is a process for determining the solid dimensions of a radiopaque object from steroscopic roentgenograms. The author feels that this method is an aid to all those conditions wherein the knowledge of solid dimensions is an aid in diagnosis.—*E. P. Pendergrass.*

Schinz, Hans R. Spital und "Röntgenbetrieb." (Hospital and roentgen laboratory.) *Schweizer. med. Wchnschr.*, 1930, *60*, 285; 314.

These two articles give valuable suggestions regarding the organization of an x-ray Department, particularly in relation to the General Hospital. While it does not lend itself to abstracting, it is recommended for study in the original.—*E. A. Pohle.*

Markl, J. Emanationstherapie und physiologische Dosierung. (Emanation therapy and physiological dosage.) *Strahlentherapie*, 1930, *36*, 197–198.

To obtain some information on the amount of radium emanation necessary to produce physico-chemical changes in the organism, the author records the effective amounts of emanation in the blood after the drinking of water with 200,000 M.E. A rapid increase of emanation in the blood after the application was observed; it reached a maximum in a few minutes. A similar curve was found for the gastric juice. From the observations on the emanation in the blood the total number of alpha particles per cubic centimeter was calculated for a two hour experiment and found to be 10368, and the energy per cubic centimeter and second was found to be 1.73×10^{-5} erg. This energy agrees well with the threshold value of a biologically active radiation energy as found by Zwaardemaker.—*Otto Glasser.*

Russo, C. Die Bedeutung der induktiven Feinregelung und der Fernsteuerung bei Röntgenapparaten. (The significance of inductive precision regulation and distant control of the roentgen apparatus.) *Strahlentherapie*, 1930, *36*, 199.

In order to keep the voltage of the roentgen apparatus constant, it is advisable to use an inductive control in the primary, such as an autotransformer with sliding contact or an arrangement of subdividing the primary of the main transformer for coarse regulation, and an inductive precision control for fine regulation. The latter can be placed between the subdivided primary windings of the main transformer. An ordinary ohm resistance in the primary is not to be recommended on account of the large voltage drop in case of fluctuation in the line voltage.—*Otto Glasser.*

Adler, Karl. Die biologische Wirkung der kurzwelligen Strahlen auf den Stoffwechsel der Zelle. (The biological effect of short wave radiation upon the metabolism of the cell.) *Strahlentherapie* 1930, *36*, 1–31.

A basal metabolism and histological examination was made of 15 normal unirradiated testes of rats; of 48 testes irradiated with a dose of 600 r (180 kv., 4 mm. Al, 0.5 mm. Zn, 30 cm. focal distance); of 15 irradiated with 2500 r; and of 16 irradiated with 2400 mg-el-hr. of radium.

Immediately after irradiation no changes in the metabolic rate could be found. The first changes, decrease of metabolism and increase of aerobic and anaerobic glycolysis, appear twenty-four hours after irradiation and reach a maximum about thirty-four days after irradiation. At the same time a histological examination reveals degenerative changes in the nuclei of the sperm producing cells. The same changes, only faster, take place after application of the higher doses. The type of the metabolic change of the cell after irradiation is the

same as that of malignant tumors, and perhaps points in the direction in which a carcinoma is formed by chronic damage with small doses of roentgen or radium rays.—*Otto Glasser.*

Murphy, Douglas, P., and de Renyi, Marguerite. Postconception pelvic irradiation of the albino rat (Mus norvegicus); its effect upon the offspring. *Surg., Gynec. & Obst.*, May, 1930, *50*, 861–863.

In a previous study of the clinical group, the author found that in a group of 76 full term children, irradiated in utero, 18 were microcephalic, while still other developmental defects were exhibited by the remaining group. This present study was to find out whether embryonic irradiation in non-lethal doses would not be followed by the birth of young exhibiting gross structural abnormalities. The author's summary is as follows:

1. The litters of 34 female albino rats irradiated when pregnant have been studied.

2. In 5 of these 34 litters one or more young exhibited either clubbing of feet or absence of toes.

3. The frequency with which defective young were produced appeared to vary directly with the degree of exposure.

4. Though no definite conclusion can be drawn from the observations set down in the present paper, due largely to the scantiness of material available for analysis, it is significant that the deformities observed among the young animals irradiated when pregnant have not been duplicated in a series of 125,000 non-irradiated control animals.

The factors and method of the experiments are detailed.—*E. P. Pendergrass.*

Markl, J. Ueber die theoretischen Grundlagen der internen Radiumtherapie, Emanationstherapie und biologische Dosierung. (The theoretical foundations of internal radium therapy, emanation therapy and biological dosage.) *Strahlentherapie*, 1930, *36*, 337–346.

In order to study the amount of radioactive substances taken internally which produce noticeable physical and chemical changes, the author examined the radioactivity of the blood taken from patients who drank 100 c.c. of water treated with 200,000 ME (Mache units) of emanation by means of a Becker emanometer. A calculation of the number of alpha particles which are active in such an experiment, permits one to calculate the energy per cubic centimeter of liquid. A mean value of 2.12×10^{-5} erg per cubic centimeter and second was found. Though this energy is extremely small, it may well produce biological and chemical effects, as has been shown by a number of experimenters. The value found agrees, for instance, quite well with the energy of 10^{-5} to 10^{-6} erg per second and cubic centimeter which Zwaardemaker found necessary to re-start the function of the non-beating heart.—*Otto Glasser.*

Piccard, A., and Stahel, E. Die Bedeutung der sekundären Betastrahlen bei Fragen der Gammastrahlen-Therapie. (The significance of the secondary beta rays in problems of gamma-ray therapy.) *Strahlentherapie*, 1930, *36*, 347–359.

Since secondary beta rays are always emitted at the impact of gamma rays with matter, and since the biological effect of gamma rays is due to the formation of secondary beta rays, an exact knowledge of the intensity of these secondary, or beta, rays is necessary for accurate dosage with gamma-ray therapy. To this end a careful investigation was made of the influence of the filter material, the position of the filter and diaphragms upon the secondary beta radiation, and also of the possibility of using magnetic fields for the deflection of the beta rays. The intensity measurements were carried out by an ionization method. The ionization chamber for the beta-ray measurements had a window of 0.003 mm. aluminum foil. The method used was that of charging up a string electrometer by means of the ionization produced. A careful examination of the secondary beta rays produced by various filters (platinum, gold, brass) was also made with a micro-ionization chamber of a volume of only 2 cubic millimeters. The results of these experiments show that the so-called secondary filter (aluminum, rubber, etc.) as commonly used in radium therapy, is superfluous, since these filters have practically no influence on the secondary radiation. Further extensive experiments with a strong magnetic field, and also with various positions of the filter and the addition of a diaphragm permitted giving distant treatments with radium with a relatively low density of radiation into the surface layers of the tissue, thus considerably increasing the percentage of the deep dose.—*Otto Glasser.*